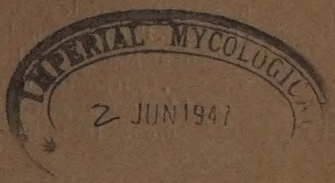
COMPTES RENDUS
(DOKLADY)
DE L'ACADÉMIE DES SCIENCES DE L'URSS

NOUVELLE SÉRIE

1943



VOLUME XL

№ 9

ÉDITION DE L'ACADÉMIE DES SCIENCES DE L'URSS
MOSCOU

AVIS AUX AUTEURS

Les «Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS» paraissent tous les dix jours. Neuf numéros composent un volume pourvu d'une table des matières. Il y a quatre volumes par année.

Les «Comptes Rendus de l'Académie des Sciences de l'URSS» en de courtes communications précisent l'essentiel des travaux en préparation. Ces articles, ne dépassant pas en règle générale quatre pages, sont donnés en anglais, en français ou en allemand. Ils embrassent les sciences mathématiques, physiques, naturelles et appliquées, mettant au jour les résultats de recherches scientifiques en cours ou qui viennent d'être achevées, et représentant ainsi les plus récentes données de l'investigation scientifique.

L'auteur a droit à 50 exemplaires de son article.

Adressez les manuscrits à la Rédaction des «Comptes Rendus», Moscou, Wolkhonka, 14.

30 Septembre

COMPTES RENDUS

(DOKLADY)

DE L'ACADÉMIE DES SCIENCES DE L'URSS

COMITÉ DE RÉDACTION

A. Arbusov, de l'Académie, A. Borissiak, de l'Académie, V. Chlopin, de l'Académie, A. Deborin, de l'Académie, A. Fersman, de l'Académie, A. Frumkin, de l'Académie, A. Kolmogoroff, de l'Académie (vice rédacteur), L. Orbeli, de l'Académie (rédacteur en chef), A. Richter, de l'Académie, S. Soboleff, de l'Académie, S. Wawilow, de l'Académie (vice rédacteur)

NOUVELLE SÉRIE

11-me année

Paraissant tous les dix jours

1943

VOLUME XL, № 9

TABLE DES MATIÈRES

Pages

MATHÉMATIQUES

M. Bockstein. Homological Invariants of the Topological Product of Two Spaces 339

PHYSIQUE MATHÉMATIQUE

V. A. Fock, Member of the Academy. Electrical Field near a Depression in a Conducting Plane 343

PHYSIQUE

E. A. Poray-Koshitz. On the Structure of Complex Glasses 346

CHIMIE

A. L. Agafonova and J. V. Khodakov. Selenic Acid as a Twin of Sulphuric Acid 350

A. L. Liberman and B. A. Kasansky. Direct Synthesis of Olefins with a Quaternary Carbon Atom through Organomagnesium Compounds 353

GÉOLOGIE

P. V. Vassiliev. On the Structure of the Coal-Bearing Formations of the Chusovaya Coal Region in the Urals 356

J. D. Zekkel. Significance of Geostructural Processes in Developing Plain Relief 359

MINÉRALOGIE

E. Bohnstedt-Kupletskaya. On the Mineralogy of the Karassev and South-Konev Tungsten Deposits in the Central Urals 362

MICROBIOLOGIE

B. A. Rubin and **O. P. Pushkinskaya.** Microbe Complex Responsible for Rot of Sugar-Beet Stored under Conditions of Kirghizia 365

PHYSIOLOGIE VÉGÉTALE

M. Ch. Čajlachjan. Content of Vitamin C in Wild Roses of Armenia 369

MORPHOLOGIE ÉVOLUTIONNAIRE

W. N. Shedenow. Functional Structure of *valvula foraminis ovalis* of Foetal Heart and Some Questions of Blood Circulation through *for. ovale* in Higher Mammals and Man 372

PALÉONTOLOGIE

M. V. Kulikov. On the Nature of the Sylva Reefs 375

HELMINTHOLOGIE

A. A. Sobolev. Trend of Evolution in Trematodes of the Family *Philophthalmidae* 378

Le présent numéro est suivi de l'indice au volume XL.

Édition de l'Académie des Sciences de l'URSS
Moscou 1943

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

MATHEMATICS

HOMOLOGICAL INVARIANTS OF THE TOPOLOGICAL PRODUCT OF TWO SPACES

By M. BOCKSTEIN

(Communicated by A. N. Kolmogoroff, Member of the Academy, 17. V. 1943)

Let A and B be any two locally bicompact topological spaces. Their topological product $A \times B$ is likewise a locally bicompact space.

Let $\mathfrak{Q}_A^\alpha = \{\varphi_i^\alpha\}$ $(i = 1, \ldots, s_\alpha)$, $\mathfrak{Q}_B^\beta = \{\psi_j^\beta\}$ $(j = 1, \ldots, t_\beta)$ be some (finite) coverings of the spaces A and B, respectively. $\mathfrak{Q}_A^\alpha \times \mathfrak{Q}_B^\beta = \{\varphi_i^\alpha \times \psi_j^\beta\}$ $(i = 1, \ldots, s_\alpha;\ j = 1, \ldots, t_\beta)$ is then a covering of the product $A \times B$. Although the totality of coverings of this kind does not exhaust all coverings of $A \times B$, it is evidently cofinal with the set of all coverings of $A \times B$. Therefore, to define the groups and the rings of ∇-homologies of the space $A \times B$, we may restrict ourselves to the consideration of this form (1).

Let f_α^q and φ_β^r be some integral chains of the coverings $\mathfrak{Q}_A^\alpha$ and $\mathfrak{Q}_B^\beta$, respectively. We define the direct product $f_\alpha^q \times \varphi_\beta^r$ of chains as follows:

$$[f_\alpha^q \times \varphi_\beta^r](\varphi_{i_0}^\alpha \times \psi_{j_0}^\beta, \ldots, \varphi_{i_{q+r}}^\alpha \times \psi_{j_{q+r}}^\beta) = f_\alpha^q(\varphi_{i_0}^\alpha, \ldots, \varphi_{i_q}^\alpha)\varphi_\beta^r(\psi_{j_q}^\beta, \ldots, \psi_{j_{q+r}}^\beta)$$

($f_\alpha^q \times \varphi_\beta^r$ is thus a $(q+r)$-chain of the covering $\mathfrak{Q}_A^\alpha \times \mathfrak{Q}_B^\beta$). It is not difficult to show that all integral ∇-chains, as well as the ∇-chains mod m, are up to homologies linear combinations of such products [analogous to ordinary homologies in the case of products of complexes; see, for instance (2)]. Moreover, in every term of these linear combinations the integral chains f_α^q and φ_β^r may be taken from the quasi-canonical bases (3) of integral chains (relative to ∇-homologies) of the coverings $\mathfrak{Q}_A^\alpha$ and $\mathfrak{Q}_B^\beta$.

It is easy to find the conditions that a linear combination of such kind be really a ∇-cycle (a ∇-cycle mod m), i, e. the conditions of vanishing (modulo m) of its ∇-boundary. By our definition of the direct product of chains we evidently have

$$\nabla(f_\alpha^q \times \varphi_\beta^r) = \nabla f_\alpha^q \times \varphi_\beta^r + (-1)^q f_\alpha^q \times \nabla\varphi_\beta^r.$$

Hence, in virtue of the definition of a quasi-canonical basis and the linear independence of its elements, the required condition is that our linear combination be representable in the form (we disregard the terms homologous to zero)

$$\sum_{r,i,k} \alpha_{ik}^r b_i^r \times b_k'^{q-r} + \sum_{r,i,k} \beta_{ik}^r b_i^r \times c_i'^{q-r} + \sum_{r,i,k} \gamma_{ik}^r c_i^r \times b_k'^{q-r} +$$

$$+ \sum_{r,i,k} \delta_{ik}^r c_i^r \times c_k'^{q-r} + \sum_{r,i,k} \varepsilon_{ik}^r \frac{1}{(\vartheta_i^{r+1}, \vartheta_k^{q-r})} \nabla(d_i^r \times d_k'^{q-r-1}),$$

where α^r_{ik}, β^r_{ik}, γ^r_{ik}, δ^r_{ik}, ε^r_{ik} are integers, b^r_i, c^r_i, d^r_i and b'^{q-r}_k, c'^{q-r}_k, d'^{q-r}_k are integral chains from the corresponding quasi-canonical bases

$$\{a^q_i,\ b^q_i,\ c^q_i,\ d^q_i,\ e^q_i\}\ (\nabla a^q_i=0,\ \nabla b^q_i=0,\ \nabla c^q_i=0,\ \nabla d^q_i=\vartheta^{q+1}_i\, b^{q+1}_i,\ \nabla e^q_i=$$
$$=a^{q+1}_i;\ \vartheta^{q+1}_i>1;\ q=0,1,2,3\ldots)\ \text{and}\ \{a'^q_i,\ b'^q_i,\ c'^q_i,\ d'^q_i,\ e'^q_i\}\ (\nabla a'^q_i=0,$$
$$\nabla b'^q_i=0,\ \nabla c'^q_i=0,\ \nabla d'^q_i=\vartheta^{q+1}_i b'^{q+1}_i,\ \nabla e'^q_i=a'^{q+1}_i;\ \vartheta^{q+1}_i>1;\ q=0,1,2,3\ldots)$$

of chains of the coverings $\mathfrak{Q}^\alpha_A$ and $\mathfrak{Q}^\beta_B$. Consequently, every integral ∇-cycle from $\mathfrak{Q}^\alpha_A\times\mathfrak{Q}^\beta_B$ is a finite linear combination of direct products of integral cycles from $\mathfrak{Q}^\alpha_A$ and $\mathfrak{Q}^\beta_B$ and of ∇-boundaries of direct products of closed mod m integral chains from $\mathfrak{Q}^\alpha_A$ and $\mathfrak{Q}^\beta_B$ divided by m*. The converse is evident: every such linear combination is an integral ∇-chain. An analogous but a little more complicated condition can be obtained for ∇-cycles mod m.

We now shall give the definition of the complete modular spectrum of ∇-groups and of ∇-rings of a topological space different from that of the modular ∇-spectrum given in my previous note (4). The complementary homomorphisms will be used in the definition. We first introduce the notation. Let χ^m_0 denote an arbitrary homomorphism that carries any element of the q-dimensional ∇-group of A into an element of the $(q+1)$-dimensional integral ∇-group of A (i. e. an integral ∇-class) containing the $1/m$-th of the ∇-boundary of an integral q-chain closed mod m, which, being reduced modulo m, gives a q-dimensional ∇-cycle mod m from the given element of the modular ∇-group. Under the complete modular spectrum of ∇-groups of a locally compact space A we understand the set consisting: 1°. Of all ∇-groups (of all dimensions) of A, integral and modulo p^k, where p are primes and $k=1,2,\ldots,$. 2°. Of homomorphisms $\pi^{m'}_m$ and $\omega^m_{m'}$ defined in my paper (4). 3°. Of all homomorphisms χ^m_0. To define the complete modular spectrum of ∇-rings it suffices to substitute the ∇-rings for the ∇-groups in the above definition. The complete modular spectra of ∇-groups and ∇-rings are evidently topological invariants of the space A.

Theorem 1. *The complete modular spectrum of ∇-rings (∇-groups) of the topological product $A\times B$ of the spaces A and B and hence, according to* (1), *the ∇-rings (∇-groups) of $A\times B$ over arbitrary fields of coefficients are determined by the complete modular spectra of A and B.*

We first show how to find the *integral* ∇-groups of $A\times B$. As we already know, every integral ∇-cycle of $A\times B$ is a linear combination of direct products of integral ∇-cycles of the $1/m$-ths of ∇-boundaries of the direct products of integral chains closed modulo m. Denote by $\{\underset{0}{u},\ \underset{0}{\varrho}\}$ the integral ∇-class containing the direct product of ∇-cycles of the integral ∇-classes $\underset{0}{u}$ and $\underset{0}{\varrho}$, and by $[\underset{m}{u},\ \underset{m}{\varrho}]$ the integral ∇-class containing the $1/m$-th of the ∇-boundary of the direct product of closed mod m chains corresponding to the modular ∇-cycles from the ∇-classes $\underset{m}{u}$ and $\underset{m}{\varrho}$. By an argument analogous to that in (4) we obtain that the integral q-dimensional ∇-group $\nabla^q_0(A\times B)$ of the space $A\times B$ is the totality of finite linear forms relative to the pairs

$$\{\underset{0}{u^r},\ \underset{0}{\varrho^{q-r}}\}\ \text{and}\ [\underset{m}{u^r},\ \underset{m}{\varrho^{q-r-1}}]\ (u^r\in\nabla^r_0(A),\ \underset{0}{\varrho^{q-r}}\in\nabla^{q-r}_0(B),\ \underset{m}{u^r}\in\nabla^r_m(A),$$
$$\underset{m}{\varrho^{q-r-1}}\in\nabla^{q-r-1}_m(B);\ r=0,1,2,\ldots,q;\ m=p^z=2,3,4,5,7,8,9,11,\ldots)$$

---

* We say that the integral chain is closed (or that it is an integral ∇-cycle) if its ∇-boundary is zero. We say that the integral chain is closed modulo m if its ∇-boundary is $\equiv 0$ mod m. One can obtain a ∇-cycle mod m from a closed mod m integral chain by reducing modulo m the coefficients of the chain.

with integral coefficients. For such forms the following identification rules are presupposed:

$$[\pi_m^{m'}(u^r),\ \pi_{m'}^{m'}(\varrho^{q-r-1})] = \frac{m'}{m}[u^r,\ \varrho^{q-r-1}] \quad (m/m'),$$

$$[\omega_{m'}^{m}(u^r),\ \omega_{m}^{m'}(\varrho^{q-r-1})] = \frac{m'}{m}[u^r,\ \varrho^{q-r-1}] \quad (m/m' \neq 0),$$

$$[u^r,\ \pi_m^0(\varrho^{q-r-1})] = \{\chi_0^m(u^r),\ \varrho^{q-r-1}\},$$

$$[\pi_m^0(u^r),\ \varrho^{q-r-1}] = (-1)^r\{u^r,\ \chi_0^m(\varrho^{q-r-1})\}.$$

The pairs $\{u^r, \varrho^{q-r}\}$ of elements of integral ∇-groups $\nabla_0^r(A)$ and $\nabla_0^{q-r}(B)$ of the spaces A and B, as well as the pairs $[u^r, \varrho^{q-r-1}]$ of elements of ∇-groups $\nabla_m^r(A)$ and $\nabla_m^{q-r-1}(B)$ of these spaces that play the rôle of variables of our linear forms, are supposed to be bilinear in u^r, ϱ^{q-r} and u^r, ϱ^{q-r-1}, respectively.

Analogously, using the similar condition for ∇-cycles mod m, we can find that the q-dimensional ∇-group mod m $\nabla_m^q(A\times B)$ of the topological product of the spaces A and B is isomorphic to the totality of linear forms with coefficients from the ring of congruence classes modulo m with respect to the pairs

$$\{u^r, \varrho^{q-r}\} \quad (u^r \in \nabla_{m'}^r(A),\ \varrho^{q-r} \in \nabla_{m'}^{q-r}(B);\ m'/m) \text{ and}$$

$$[u^r, \varrho^{q-r-1}] \quad (u^r \in \nabla_{m'}^r(A),\ \varrho^{q-r-1} \in \nabla_{m'}^{q-r-1}(B);\ m' = 2, 3, 4, 5, 7, 8, 9, 11, \ldots)$$

with the following identification rules:

$$\{\pi_{m''}^{m'}(u^r),\ \pi_{m'}^{m''}(\varrho^{q-r})\}_m = \frac{m''}{m'}\{u^r,\ \varrho^{q-r}\}_m \quad (m'/m''/m),$$

$$\{\omega_{m''}^{m'}(u^r),\ \omega_{m'}^{m''}(\varrho^{q-r})\}_m = \frac{m''}{m'}\{u^r,\ \varrho^{q-r}\}_m \quad (m'/m''/m)$$

$$[\pi_{m''}^{m'}(u^r),\ \pi_{m''}^{m''}(\varrho^{q-r-1})]_m = \frac{m''}{m'}[u^r,\ \varrho^{q-r-1}]_m \quad (m'/m''),$$

$$[\omega_{m''}^{m'}(u^r),\ \omega_{m''}^{m''}(\varrho^{q-r-1})]_m = \frac{m''}{m'}[u^r,\ \varrho^{q-r-1}]_{m'} \quad (m'/m'')$$

$$[u^r,\ \pi_{m'}^0(\varrho^{q-r-1})]_m = \{\pi_m^0(\chi_0^{m'}(u^r)),\ \pi_m^0(\varrho^{q-r-1})\}_m,$$

$$[\pi_{m'}^0(u^r),\ \varrho^{q-r-1}]_m = (-1)^r\{\pi_m^0(u^r),\ \pi_m^0(\chi_0^{m'}(\varrho^{q-r-1}))\}_m$$

(we again suppose $\{u^r, \varrho^{q-r}\}$ and $[u^r, \varrho^{q-r-1}]_m$ to depend bilinearly on u and ϱ).

To find the complete modular spectrum of ∇-groups of $A\times B$ it remains to determine the homomorphisms $\pi_m^{m'}$, $\omega_{m'}^m$ and χ_0^m. It evidently suffices to determine them for the pairs $\{u, \varrho\}$ and $[u, \varrho]$. It is easy to see that

$$\pi_m^{m'}(\{u, \varrho\}_{m'}) = \begin{cases} \frac{m'}{m}\{u, \varrho\}_m & \text{for } m''/m/m' \\ \frac{m'}{m''}\{\pi_{m''}^{m''}(u), \pi_{m''}^{m''}(\varrho)\}_m & \text{for } m/m''/m' \end{cases}$$

$$\pi_m^{m'}([u, \varrho]_{m'}) = [u, \varrho]_m,$$

$$\omega_{m'}^m(\{u, \varrho\}_m) = \{u, \varrho\}_{m'}$$

$$\omega^m_{m'}([u, v]_m) = \frac{m'}{m}[u, v]_{m'},$$

$$\chi^m_0([u, v]_m) = [u, v],$$

$$\chi^m_0([u, v]_m) = 0.$$

Theorem 1 can be applied to the determination of the topological dimension of the product of spaces when the dimensions of the factors are known. It is known that the Urysohn-Brower dimension [i. e. the integral ∇-dimension(5)] of the product of two spaces is not determined by the dimensions of the factors. Nevertheless, using the above result, we can show that if we know the ∇-dimensions of A and B over the complete system of fields of coefficients R, R_p, C_p, Q_p(5), then the ∇-dimensions of the topological product $A \times B$ over this complete system can be easily calculated. Namely, we have.

Theorem 2. *The ∇-dimension of the topological product $A \times B$ of two bicompact spaces A and B over the fields of coefficients R, R_p, C_p is the sum of ∇-dimensions of the factors over the corresponding fields of coefficients. As to the ∇-dimensions over Q_p, we have* $\mathrm{Dim}_{Q_p}(A \times B) = \max\{\mathrm{Dim}_{C_p}A + \mathrm{Dim}_{Q_p}B,\ \mathrm{Dim}_{Q_p}A + \mathrm{Dim}_{C_p}B\}$, *where* $\mathrm{Dim}_G A$ *denotes the ∇-dimension of A over G.*

The proof of this theorem is based upon the following considerations: According to(5), the ∇-dimension is q, if the q-dimensional local ∇-group is non trivial, but all r-dimensional $(r > q)$ local ∇-groups are trivial. The non-triviality of the ∇-group over R means that the integral ∇-group contains an element of infinite order; the non-triviality of the ∇-group over R_p implies the existence of an integral ∇-group of infinite order or of order p, etc.(5). The application of the construction outlined in the present note to establishing the triviality or the non-triviality of the integral and the modular ∇-groups of the topological product yields the proof of Theorem 2.

Mathematical Institute,
Academy of Sciences of the USSR.

Received
17. V. 1943.

REFERENCES

[1] P. S. Alexandroff, Trans. Amer. Math. Soc., 49, 41—105 (1941). [2] Alexandroff-Hopf, Topologie, I, chapt. VII, § 3, 1935. [3] Lefschetz, Topology, 27, 1930. [4] M. Bockstein, C. R. Acad. Sci. URSS, XXXVII, No. 9 (1942). [5] M. Bockstein, ibid., XXXVIII, No. 7 (1943).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

MATHEMATICAL PHYSICS

ELECTRICAL FIELD NEAR A DEPRESSION IN A CONDUCTING PLANE

By V. A. FOCK, Member of the Academy

Imagine an absolutely conducting plane with a depression (for instance, in the form of a hemisphere), whose surface is likewise an absolute conductor of electricity. Suppose a radio-wave of length λ, very large compared to the linear dimensions a of the depression, to fall upon the plane. Then one may introduce a length l such that $a \ll l \ll \lambda$. In a volume with linear dimensions l adjoining the depression the field may be looked upon as electrostatic (because $l \ll \lambda$). On the other hand, as $a \ll l$, the boundary conditions for this electrostatic field may be taken such as if it were occupying all the space over the plane.

In that way the problem of determining the field due to a radio-wave is reduced to the following electrostatic problem. The value E of the constant electrostatic field at a great distance from the plane being given, we are to determine the potential Φ which satisfies Laplace's equation, behaves at infinity like Ez, and vanishes on the conductor. (The field at infinity is perpendicular to the conducting plane which we take for the z-plane).

The problem will be solved here for the case when the depression is formed by a spherical surface crossing the plane at an angle γ. For the depression in its proper sense we have $\pi < \gamma < 2\pi$; if the depression is a hemisphere, we have $\gamma = \frac{3}{2}\pi$. In the case of a convex surface (negative depression) $0 < \gamma < \pi$. The radius of the sphere R and the radius of the opening a are connected by the relation: $a = |R \sin(2\pi - \gamma)|$.

In the sequel we take $a = 1$. The units for the field are so chosen that the potential at infinity behaves like the coordinate z, or, more accurately, that the difference $\Phi - z$ remains finite at infinity.

Let us introduce toroidal coordinates ϑ and φ connected with the ordinary cylindrical coordinates $r = \sqrt{x^2 + y^2}$ and z by the relations

$$r = \frac{\operatorname{sh}\vartheta}{\operatorname{ch}\vartheta - \cos\varphi}; \quad z = \frac{\sin\varphi}{\operatorname{ch}\vartheta - \cos\varphi}. \tag{1}$$

Then the conductor will have the coordinate surfaces $\varphi = 0$ and $\varphi = \gamma$ for boundaries. The potential Φ will be sought in the form

$$\Phi = -\sqrt{2(\operatorname{ch}\vartheta - \cos\varphi)}\,\frac{\partial\chi}{\partial\varphi}, \tag{2}$$

where χ depends solely upon ϑ and φ, and satisfies the equation

$$\frac{\partial^2\chi}{\partial\vartheta^2} + \operatorname{cth}\vartheta\,\frac{\partial\chi}{\partial\vartheta} + \frac{\partial^2\chi}{\partial\varphi^2} + \frac{1}{4}\chi = 0 \tag{3}$$

and the boundary conditions

$$\frac{\partial \chi}{\partial \varphi} = 0 \quad \text{for} \quad \varphi = 0 \quad \text{and} \quad \varphi = \gamma. \tag{4}$$

To infinitely remote points of the physical space there corresponds the point $\varphi = 0$; $\vartheta = 0$; there the function $\chi(\vartheta, \varphi)$ must have a singularity such that the expression for the potential Φ contain a member linear with respect to the coordinate z. For this we have only to put

$$\chi = \frac{2}{\sqrt{2(\operatorname{ch}\vartheta - \cos\varphi)}} + \chi^*, \tag{5}$$

where the function χ^* has no singularity. The function χ^* should satisfy the equation (3) and the boundary conditions resulting from (4) and (5). Equation (3) admits of separation of variables and has a particular solution of the form

$$\chi = P_{i\mu - \frac{1}{2}}(\operatorname{ch}\vartheta) \operatorname{ch}\mu\varphi, \tag{6}$$

where P is Legendre's spherical function with a complex index. Multiplying the particular solution (6) by a certain function of the parameter μ and integrating, we may write

$$\chi^* = 2\int_0^\infty P_{i\mu - \frac{1}{2}}(\operatorname{ch}\vartheta) \frac{\operatorname{ch}\mu\varphi}{\operatorname{sh}\mu\gamma} F(\mu)\, d\mu. \tag{7}$$

This expression remains finite everywhere and satisfies the equation (3) and the boundary condition at $\varphi = 0$. To make it also satisfy the boundary condition at $\varphi = \gamma$, we should so choose the function $F(\mu)$ that

$$\int_0^\infty P_{i\mu - \frac{1}{2}}(\operatorname{ch}\vartheta) F(\mu)\mu d\mu = \frac{\sin\gamma}{[2(\operatorname{ch}\vartheta - \cos\gamma)]^{3/2}}. \tag{8}$$

This may easily be done if we use the theorem on the expansion of an arbitrary function in an integral involving Legendre's functions with a complex index [this theorem was established by the author in an earlier paper (1)]. Applying this theorem to the present case, one obtains

$$F(\mu) = \operatorname{th}\mu\pi \int_1^\infty P_{i\mu - \frac{1}{2}}(x) \frac{\sin\gamma}{[2(x - \cos\gamma)]^{3/2}}\, dx = \frac{\operatorname{sh}\mu(\pi - \gamma)}{\operatorname{ch}\mu\pi}. \tag{9}$$

The substitution of this expression in (7) gives

$$\chi^* = 2\int_0^\infty P_{i\mu - \frac{1}{2}}(\operatorname{ch}\vartheta) \frac{\operatorname{ch}\mu\varphi}{\operatorname{sh}\mu\gamma} \frac{\operatorname{sh}\mu(\pi - \gamma)}{\operatorname{ch}\mu\pi}\, d\mu. \tag{10}$$

Making use of the integral representation

$$P_{i\mu - \frac{1}{2}}(\operatorname{ch}\vartheta) = \operatorname{ch}\mu\pi \frac{2}{\pi}\int_0^\infty \frac{\cos\mu x\, dx}{\sqrt{2(\operatorname{ch}\vartheta + \operatorname{ch} x)}} \tag{11}$$

for Legendre's function, it is possible to carry out the integration with respect to μ.

One obtains

$$\chi^* = -2\int_0^\infty \frac{L(x)\, dx}{\sqrt{2(\operatorname{ch}\vartheta + \operatorname{ch} x)}} \tag{12}$$

where

$$L(x)=\frac{1}{4\gamma}\left\{\operatorname{ctg}\frac{\pi(\pi+\varphi+ix)}{2\gamma}+\operatorname{ctg}\frac{\pi(\pi+\varphi-ix)}{2\gamma}+\right.$$
$$\left.+\operatorname{ctg}\frac{\pi(\pi-\varphi+ix)}{2\gamma}+\operatorname{ctg}\frac{\pi(\pi-\varphi-ix)}{2\gamma}\right\}. \qquad (13)$$

By deforming the integration path in the plane of the complex variable x and separating out the residuum in a pole, one easily obtains from (12) the formula

$$\chi^*=-\frac{2}{\sqrt{2(\operatorname{ch}\vartheta-\cos\varphi)}}+\frac{2}{\gamma}\int_{\vartheta}^{\infty}\frac{\operatorname{sh}\frac{\pi t}{\gamma}}{\operatorname{ch}\frac{\pi t}{\gamma}-\cos\frac{\pi\varphi}{\gamma}}\frac{dt}{\sqrt{2(\operatorname{ch}t-\operatorname{ch}\vartheta)}}. \qquad (14)$$

The operations which have led us from (10) to (14) are lawful on the assumption $0<\varphi<\pi<\gamma$. Yet, the result holds good within wider limits, namely for $-2\pi<\varphi<2\pi$, when $\gamma>\pi$, and for $-2\gamma<\varphi<2\gamma$, when $0<\gamma<\pi$.

In particular, for $\gamma=\pi$ we have $\chi^*\equiv 0$, which is easy to verify by computing the value of the integral on the right-hand side of (14).

Substituting (14) in (15), we obtain definitely

$$\chi=\frac{2}{\gamma}\int_{\vartheta}^{\infty}\frac{\operatorname{sh}\frac{\pi t}{\gamma}}{\operatorname{ch}\frac{\pi t}{\gamma}-\cos\frac{\pi\varphi}{\gamma}}\frac{dt}{\sqrt{2(\operatorname{ch}t-\operatorname{ch}\vartheta)}}. \qquad (15)$$

When $\frac{\gamma}{\pi}$ is a rational number, the potential and the field on the axis of symmetry ($\vartheta=0$) can be expressed in finite terms.

Leningrad University.

Received
15. VI. 1943.

REFERENCES

[1] V. A. Fock, C. R. Acad. Sci. URSS, XXXIX, No. 7 (1943).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

PHYSICS

ON THE STRUCTURE OF COMPLEX GLASSES

By E. A. PORAY-KOSHITZ

(Communicated by A. F. Joffe, Member of the Academy, 3. V. 1943)

By the adherents of the theory of continuous three-dimensional random (non-crystalline) atomic (ionic) network, implying a full homogeneity of both simple and binary glasses (1), the question as to the possibility of estimating separate chemical compounds in binary glasses has been answered in the negative. However, the results of a number of experimental studies devoted to X-ray investigation of the structure of various complex glasses (2) point to the presence of chemical ingredients in the form of chemically heterogeneous crystallites. Similar results have been obtained by Meyer (3) for some binary liquids (phenol-water mixture) and by Danilov (4) (liquid alloys of Bi—Sn, Sn—Pb, Pb—Bi and Sn—Zn). In all the studies cited above the X-ray photographs were interpreted with the aid of the so-called method of additivity; the latter aims at reducing the curve of X-ray scattering by a complex glass or liquid to the sum of the scattering curves of their ingredients.

Up to the present the application of the additivity method was, however, subject to certain limitations, since the curves used were those of r e l a t i v e intensity of X-ray scattering, and the ordinates of the theoretical (summary) curves were so chosen as to secure the best coincidence of the curves with the experimental ones. It seemed therefore of interest to apply the additivity method to such experimental scattering curves which had been computed in a b s o l u t e e l e c t r o n i c u n i t s, i.e. for scattering with a single independent classically emitting electron. The more so as curves of this kind had been obtained for several complex glasses by representatives of the American school of students who adhere to the hypothesis of continuous random network (chiefly, by Warren and his co-workers).

Below, the results are described of the additivity method as applied to «absolute» scattering curves of boric oxide-silica and soda-silica glasses.

1. B o r i c O x i d e - S i l i c a G l a s s. «Absolute» scattering curves for five glasses of the system SiO_2—B_2O_3 (Table 1) have been plotted by Warren, Robinson and Biscoe (5). As this system encloses no chemical compounds between SiO_2 and B_2O_3, the additivity method is applicable here in its simplest form; viz. in that of an addition of scattering curves for vitreous SiO_2 and B_2O_3, and the more so as these curves were obtained in absolute electronic units by more than one author and with an accuracy sufficient for the purpose.

When summing up these curves, account was taken of the molecular content of the ingredients in the binary glasses of Table 1; as a result of the summation a curve was obtained in each of the five cases, showing a very good agreement with the corresponding experimental curve from the paper by Warren, Robinson and Biscoe. A certain discrepancy in the intensities of the chief maxima can easily be explained by the difficulty of determining very strong maxima with the help

Table 1

Glass Nos.	Composition in mol. per cent			
	SiO_2	B_2O_3	Na_2O	Al_2O_3
1	16.9	83.1	—	—
2	33.2	66.8	—	—
3	48.7	51.3	—	—
4	63.5	36.5	—	—
5 (pyrex)	83.3	11.5	4.0	1.2

of the photographical method. As glass No. 5 (pyrex) contains 4.0% of Na_2O and 11.5% of B_2O_3 (mol. per cent), the curve of vitreous silica was summed up in this case with that for sodium triborate ($Na_2O \cdot 3B_2O_3$) ([3]).

Fig. 1 illustrates the procedure for glass No. 3. Along the axis of abscissae there are plotted values of $\frac{\sin\vartheta}{\lambda}$ (λ, wave-length and ϑ, angle of Bragg), while along the axis of ordinates are plotted the intensities in absolute electronic units. Curve

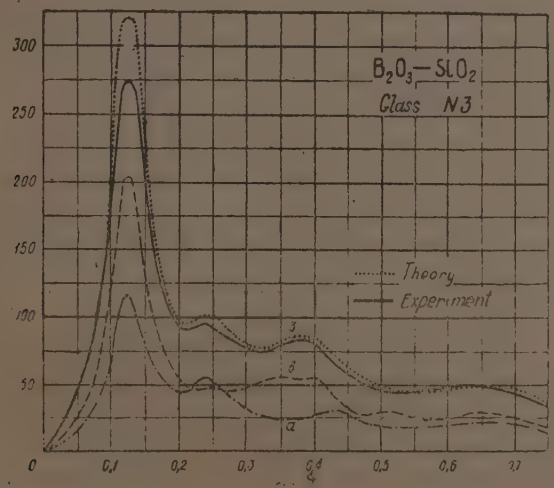


Fig. 1. Structure additivity in boric oxide-silica glass

a is that for the scattering of vitreous B_2O_3 (51.3%); curve *b* for vitreous SiO_2 (48.7%); the dotted curve *3* has been derived by summing up curves *a* and *b*, and the solid curve *3* has been obtained by experiment.

The good agreement between the theoretical and the experimental curves for the remaining four glasses (Nos. 1, 2, 4 and 5) is as convincing a proof of the fact that the structure of any binary glass of the boric acid-silica system is additively composed of the structures of vitreous silica and boric anhydrite.

2. Soda-Silica Glass. It has been shown in an earlier note ([2]) that one of the structure ingredients of soda-silica glasses is sodium metasilicate ($Na_2OSiO_2 = Na_2SiO_3$). It is a matter for regret that the scattering curve of this glass has not been given in the work by Warren and Biscoe ([6]) who have investigated five glasses of the system Na_2O—SiO_2 (Table 2). I have therefore subtracted from the scattering curves for glasses with a relatively high content of sodium metasilicate (i. e. for Nos. 3,4 and 5) the curve for vitreous silica, plotted on a scale corresponding to the molecular content in those glasses of silica not bound with Na_2O. Since a portion of SiO_2 is forming together with Na_2O sodium metasilicate (Na_2OSiO_2); the molecular

ratios of free SiO_2 in these glasses are 73.7—26.3=47.4%; 66.8—33.2=33.6% and 65.4—34.6=30.8%, respectively.

Table 2

Glass Nos.	Composition in mol. %	
	Na_2O	SiO_2
1	19.0	81.0
2	23.3	76.7
3	26.3	73.7
4	33.2	66.8
5	34.6	65.4

As a result of the subtraction, scattering curves for vitreous sodium metasilicate have been obtained on scales corresponding to 52,6, 66.4, and 69.2% mol. of Na_2SiO_3. The comparison of these curves on scales corresponding to a 100% content of Na_2SiO_3 has been made on the top of Fig. 2 (the curves bear the numbers of

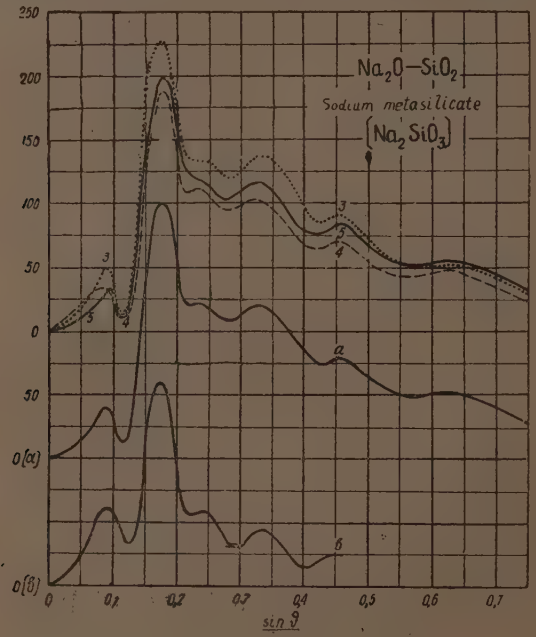


Fig. 2. Intensity curves of vitreous sodium metasilicate

the glasses from whose curves they have been plotted. Curve *a* is the arithmetical mean from the three curves).

It stands to reason that all these curves correspond to one and the same structure characterized by a total lack of a maximum at $\frac{\sin\vartheta}{\lambda}=0.122$; corresponding to vitreous silica. This would not be so if sodium metasilicate did not exist in these glasses as an individual chemical compound. The position of all maxima coincides with that of the maxima on the experimental curve of the photographic density of the vitreous sodium metasilicate (Fig. 2, curve *b*). Curve *a* in Fig.2 is thus the curve of intensity of vitreous Na_2SiO_3 expressed in abs. electronic units.

Fig. 3 shows summing up of the curves for vitreous SiO_2 (curve *b*) and Na_2SiO_3 (curve *a*) on a scale corresponding to the percentage of these compounds in glass

No. 2 (53.4% of SiO_2 and 46.6% of Na_2SiO_3). The resultant curve *2* (dotted line) coincides on the whole fairly well with the experimental curve *2* (solid line). A similar result can be obtained for glass No.1; a certain disagreement in the intensity of the chief maximum should be explained in the same way as above. In the experimental curve for glass No. 2 (Fig. 3) the two first maxima remain unsolved; on the curve of photographic density *c*, previously obtained by Valenkov and the present author ([2]), which also shows a good agreement with the resultant curve; these two maxima are solved.

It should be noted that the application of the additivity method to sodium silica glasses puts it beyond any doubt that sodium disilicate ($Na_2O \cdot 2SiO_2 = Na_2Si_2O_5$)

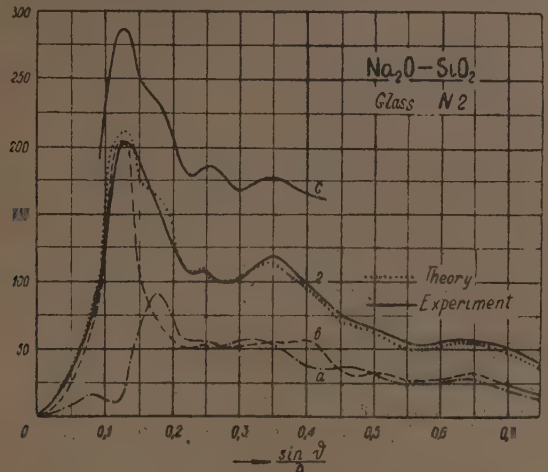


Fig. 3. Structure additivity in soda-silica glass

is not present in these glasses in any appreciable quantity. This stands in no contradiction to the fact that the product of devitrification of a glass whose composition corresponds to sodium disilicate, is $Na_2Si_2O_5$ rather than Na_2SiO_3. Glass is no equilibrial system, and in the process of crystallization of a glass whose composition lies inside the field of sodium disilicate, the transformation of sodium metasilicate into sodium disilicate may be an advantage from the viewpoint of energetics.

Thus, in spite of the fact that Warren and his co-workers have shown that some properties of glasses may well be interpreted on the ground of the mean statistical picture of atom arrangement to which the term of «random network» may lawfully be applied, the results of the present investigation confirm the existence in complex glasses of several independent structures. Glass is consequently non-homogeneous in detail, but contains areas with a relatively better regulated atom arrangement (crystallites), and it is these areas that present chemically heterogeneous elements of independent structures present in complex glasses.

Institute of General and Inorganic Chemistry.
Academy of Sciences of the USSR.

Received
3. V. 1943.

REFERENCES

[1] W. H. Zachariasen, Journ. Am. Chem. Soc., 54, 3841 (1932); B. E. Warren and A. D. Loring, Journ. Am. Ceram. Soc., 18, 269 (1935); B. E. Warren and J. Biscoe, ibid., 21, 259 and 287 (1938). [2] N. Valenkov u. E. Poray-Koshitz, ZS. Krist. (A), 95, 195 (1936); G. Hartleif, ZS. anorg. allgem. Chemie, 238, 353 (1938); E. A. Poray-Koshitz, C. R. Acad. Sci. URSS. XXXVI, No. 9 (1942); ЖОХ, 12, 196 (1942). [3] A. W. Meyer, Phys. Rev., 38, 1083 (1931). [4] V. I. Danilov, Bull. Acad. Sci. URSS, sér. phys., VI, 30 (1941). [5] B. E. Warren, C. S. Robinson and J. Biscoe, Journ. Am. Ceram. Soc., 22, 180 (1939). [6] B. E. Warren and J. Biscoe, ibid., 21, 259 (1938).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943, Volume XL, № 9

CHEMISTRY

SELENIC ACID AS A TWIN OF SULPHURIC ACID

By A. L. AGAFONOVA and J. V. KHODAKOV

(Communicated by V. G. Chlopin, Member of the Academy, 1. VI. 1943)

Since the time of Mendeleyeff there exists a conviction that the metalloid character of elements within a single group; numerically expressed by the strength of oxygen acids that are derived from them, weakens with the growth of the atomic number of the elements. As a matter of fact, from the formula deduced by us (1)

$$\frac{1.32K}{r_X} \approx 0.84 - 0.042 \lg k, \qquad (1)$$

connecting the constant of dissociation of the acid (k) with the radius of its anion (r_X), an opposite conclusion follows directly: in case of a similar constitution (and, consequently, with the same value of K) the strength of the acids within a single subgroup should increase along with the atomic number of the metalloid, in so far as r_X also increases in this case.

Highly adapted for checking up this conclusion is the pair of acids: H_2SO_4 and H_2SeO_4.

By comparing the distances X — O in the tetrahedral radicals XO_4:

Cl — O = 1.5$_7$ Å (average from 2 values) —
S — O = 1.5$_5$ » (» » 15 ») Se — O = ?
P — O = 1.5$_5$ » (from KH_2PO_4) [As — O] — [P — O] ≅ 0.1 Å
Si — O = 1.6 » (according to W. L. Bragg) [Ge — O] — [Si — O] ≅ 0.05 Å,

we have

$$r_{SO_4''} = 1.5_5 + 1.32 = 2.9 Å; \quad r_{SeO_4''} = 2.9 + 0.1 = 3.0 Å$$

wherefrom, according to formula (1) ($K = 2$) we obtain the theoretically expected values for the order of the second constants of dissociation:

for H_2SO_4 $(k' = 10^{+3.8})$ $k'' = 10^{-1.5}$
» H_2SeO_4 $(k' = 10^{+4.3})$ $k'' = 10^{-1}$

The thermodynamic value of $K''_{H_2SO_4}$ was found by Harned and Hamer (2) to be 1.31×10^{-2} (at 17°), and $K''_{H_2SeO_4}$ has not as yet been determined. It is only known that both acids are so near to each other by their strength, that e. m. f. for chains

$$PtH_2,\ H_2SO_4(c_1)\,/\,H_2SeO_4(c_2),\ H_2Pt$$

at $c_1 = c_2$ within a very broad range of concentrations practically does not differ from zero (2).

For determining $k''_{H_2SeO_4}$ we selected the following method*. In certain volumes of a very weak solution of HNO_3 with a known pH the same number of moles of the sulphate and correspondingly of the selenate is dissolved.

Then an indicator is added to both solutions, and by its colour new values for pH of both solutions are found: pH_S and pH_{Se}. Both of them have increased at the expense of a partial binding of H-ions by XO_4-ions (3). The calculations are carried out using the formula:

$$k = 10^{-pH} \cdot c_{M_2XO_4} / 10^{-pH_X} - 10^{-pH},$$

i. e. without allowance being made for electrostatical factors (ionic force).

However, it is easy to understand that the ratio of concentration constants (k) of H_2SO_4 and H_2SeO_4 found from every pair of such parallel measurements should correspond to the ratio of thermodynamic constants (K), as the ionic forces of both solutions are equal.

Therefore

$$K_{HSeO'_4} = K_{HSO'_4} \times (k_{HSeO'_4} : k_{HSO'_4}). \qquad (2)$$

Sodium selenate was prepared by heating $BaSeO_4$ to boiling with an insufficient amount (compared to the calculated one) of a solution of Na_2SO_4, until a feeble (and remaining afterwards unchanged) reaction of the solution for the sulphate ion. The inevitable contamination of Na_2SeO_4 with sulphate (0.5% according to nephelometric determination) was of no importance in our case. On the contrary, the method should be very sensitive towards contamination of the preparation with salts of weak acids, i. e. with selenite. For this reason the solution of Na_2SeO_4 before crystallization (which was carried out 3 times by partial evaporation and cooling) was tested and, if necessary, oxidized by a very weak solution of $KMnO_4$. Crystals of the decahydrate were dehydrated at 100°. As indicator methyl-orange was chosen (pK = 3.7).

By means of a spectrophotometer the absorption coefficients I_1 and I_2 were determined at two wave-lengths, corresponding to the maximum of absorption of methyl-orange in an acid and in an alkaline medium. Using $I_1/I_2 = f(pH)$ prepared beforehand, the values of pH of the investigated solutions $Na_2XO_4 + HNO_3$ were found. The pH of the initial solutions of HNO_3 varied from one experiment to the other within 3.21 and 3.43; the molar concentration of the solutions in respect of Na_2XO_4 — from 0.0125 to 0.05.

From 11 measurements the average $k''_{H_2SO_4} = 3.5 \times 10^{-2}$ was found, which practically coincided with $k' = 3.1 \times 10^{-2}$ found by Kolthoff (3) who used a similar method, and the average ratio $k''_{H_2SeO_4} : k''_{H_2SO_4} = 2.0 \pm 0.4$, deflections being from 1.4 to 2.9, i. e. somewhat above 1, as it followed from the theory.

The ratio $k''_{H_2SeO_4} : k''_{H_2SO_4}$ did not change markedly with temperature within the interval 0—60°.

Accepting (see above) $K''_{H_2SO_4}$ to be equal 1.31×10^{-2}, for H_2SeO_4 we obtain using formula (2) $K''_{H_2SeO_4} = 2 \times 1.31 \times 10^{-2} = 2.6 \times 10^{-2}$.

---

* The experimental part of the work has been carried out in the laboratory of inorganic chemistry of the Gorky State University and is published as a preliminary communication.

In the table the values for the chemical radii of the anions SO_4'' and SeO_4'' calculated using formula (1) from the values of K with their crystallochemical radii (taking as a basis in both systems of radii $r_{O''} = 1.32$ Å) are compared.

	K''	r_{chem}	r_{cryst}	Difference
SO_4''	1.3×10^{-2}	2.87 Å	2.9 Å	1%
SeO_4''	2.6×10^{-2}	2.92 Å	3.0 Å	~3%

Moscow Aviation Institute.

Received
31. V. 1943.

REFERENCES

[1] Ю. В. Ходаков, Элементы электростатич. химии, 47—53, 1934. [2] Harned and Hamer, J. Am. Chem. Soc., 57, 27 (1935). [3] Sherill and Lyons, ibid., 54, 279 (1932). [4] J. M. Kolthoff, Rec. trav. chim. Pays-Bas, 43, 207, 216 (1924). [5] Х. Т.С. Бриттон, Водородные ионы, определение и значение их в теоретич. и прикладной химии, пер. Колосовых, 1936.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

CHEMISTRY

DIRECT SYNTHESIS OF OLEFINS WITH A QUATERNARY CARBON ATOM THROUGH ORGANOMAGNESIUM COMPOUNDS

By A. L. LIBERMAN and B. A. KASANSKY

(Communicated by S. S. Nametkin, Member of the Academy, 12.III.1943)

Since Tiffeneau (1) has shown that allyl bromide and iodide readily interact with alkyl- or arylmagnesium halides to yield olefinic hydrocarbons, this reaction has been widely used by v. Braun, Deutsch and Schmatlock (2), Brooks and Humphrey (3), Kirrmann (4), Wilkinson (5), Kozačik and Reid (6) and other authors to prepare various olefins and diolefins, as well as aromatic and hexamethylene hydrocarbons with unsaturated side-chain. In one case only it was used for the preparation of an olefin with a quaternary carbon atom, namely Whitmore and Homeyer (7), and later Mulliken with collaborators (8) prepared, 4, 4-dimethylpentene-1 by treating tertiary butylmagnesium chloride with allyl bromide, the yield in the former investigation being as high as 85% of the theoretical based on the organomagnesium compound, and in the latter one only 5%. This disagreement may probably depend on the fact that Mulliken and collaborators added allyl bromide to the Grignard reagent, whereas Whitmore and Homeyer recommend the reverse procedure, having demonstrated, that this order of addition is essential to ensure a high yield of the hydrocarbon.

It is curious that allyl chloride which is considerably cheaper and more readily available than the bromide or iodide, has been utilized for Tiffeneau's reaction only in the latter few years by Platé and Tarassova (9) to prepare heptene-1 and 6-methylheptene-1 and by Henne with collaborators (9) to prepare octene-1 and the same 6-methylheptene-1.

In connexion with the syntheses of various olefins and paraffins with quaternary carbon atom in progress in our laboratory, we have prepared 4, 4-dimethylhexene-1 from tertiary amylmagnesium chloride and allyl chloride:

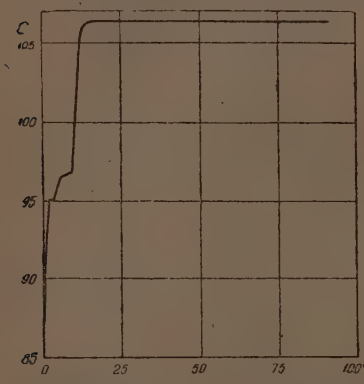
$$C_2H_5(CH_3)_2CMgCl + ClCH_2 - CH = CH_2 \rightarrow MgCl_2 + C_2H_5 - \overset{CH_3}{\underset{CH_3}{C}} - CH_2 - CH = CH_2.$$

On this example we have in a number of experiments defined more accurately the procedure for preparation of such hydrocarbons by means of allyl chloride, and shown that not only the order of addition of the reaction components to each other, but carefully controlled temperature conditions play a decisive part in ensuring a satisfactory yield of the hydrocarbon. Thus, when adding the Grignard reagent to allyl chloride at 5°, as recommended by Whitmore and Homeyer for allyl bromide, we have observed practically no interaction with the formation of the expected olefin. On the contrary, at 25 or 30° the reaction proceeded very vigorously,

but mainly diallyl and some halogen containing products with a high boiling point have been formed. The best results have been obtained by the authors at 12 to 16° (the yield of the olefin was 35% of the theoretical, based on tertiary amyl chloride).

4, 4-Dimethylhexene-1 has been mentioned in Egloff's «Physical Constants of Hydrocarbons» with reference to the investigation of Dietrich and Boord [10] communicated in an unavailable edition, which has not been referred to even in Chemical Abstracts. Therefore the method of preparation of this hydrocarbon by the above-mentioned authors is uncertain.

After fractionation of 4, 4-dimethylhexene-1 prepared by the authors of the present paper with an efficient rectification column, the hydrocarbon was found to be exceedingly pure, as it may be seen from the distillation curve and the physical constants. By hydrogenation over platinized charcoal the olefin was converted to 3, 3-dimethylhexane, also obtained in very pure state.



4. 4-Dimethylhexene-1 distillation curve

Experimental. 4, 4-Dimethylhexene-1. Tertiary amyl chloride was prepared in a 67% yield by shaking tertiary amyl alcohol with conc. hydrochloric acid.

B.p.$_{738}$ 82.5—84.7°; $n_D^{20} = 1.4057$; $d_4^{20} = 0.8659$; $MR_D = 30.20$; calcd. for $C_5H_{11}Cl$ $MR_D = 30.16$.

The Grignard reagent has been prepared according to the procedure of Whitmore and Badertscher [11], and the clear solution of the reagent decanted from the residue was kept in an atmosphere of nitrogen to avoid oxidation. In all 6 runs have been carried out at various temperatures to prepare 4, 4-dimethylhexene-1. The description of one of them, which gave the best results, is given below.

To 0.85 moles of allyl chloride (65 g in 75 ml of dry ether) at 12 to 16° and under vigorous stirring there was added dropwise within 4 hours in a flow of nitrogen the Grignard reagent obtained from 1 mole of tertiary amyl chloride in 600 ml of dry ether. The reaction mixture was left overnight and then poured into a large flask with crushed ice. The ether layer was separated, dried over $CaCl_2$ and then ether with the products boiling below 90° distilled off on a 1.5 m column with Fenske glass helices [12]. From the residue a fraction boiling from 90 to 110° has been topped off in order to get free from the high boiling products (about 10 g) which cannot be distilled without decomposition. The fraction 90 to 110° after boiling over sodium chips has been redistilled through a column packed with Fenske wire helices [13] (height of the packed section 28 cm) having the efficiency of 23 theoretical plates. The distillation results are shown in the figure. The yield in a number of runs has been from 30 to 35% of the theoretical based on tertiary amyl chloride.

4, 4-Dimethylhexene-1 prepared in this way had the following properties: b.p.$_{742}$ 106.4°; $n^{20}{}_D = 1.4106$; $d_4^{20} = 0.7209$; $MR_D = 38.61$; calcd. for C_8H_{16} $MR_D = 38.68$.

Analysis*: subst. 3.208; 2.917 mg; CO_2—10.087; 9.177 mg; H_2O—4.074; 3.758 mg. Found: C—85.75; 85.80%; H—14.22; 14.41%. Calcd. for C_8H_{16} C—85.62%; H—14.38%.

4, 4-Dimethylhexene-1 prepared by Dietrich and Boord [10] had: b. p.$_{760}$ 107.0—107.5° and b.p.$_{742}$ 106.2—106.7°; $n_D^{20} = 1.4102$; $d_4^{20} = 0.7198$.

---

* The analysis was made by S. T. Kalugina in the Laboratory for Microanalysis, Institute of Organic Chemistry, Academy of Sciences of the USSR.

3, 3-Dimethylhexane. 71 g of 4, 4-dimethylhexene-1 has been passed at 155° in a strong current of hydrogen through a tube containing 22 g of platinized charcoal catalyst (20% Pt) at a rate of 8.4 ml/h. The condensate (64 g) was shaken with conc. H_2SO_4, washed with water, dried over $CaCl_2$ and distilled from Na chips through the previously mentioned column with 23 theoretical plates efficiency. It has been obtained from 59 g of the condensate:

Fraction 110.2 to 110.9°	— 0.5 g
Fraction 110.9° flatly	— 54.0 g
Residue and losses	— 4.5 g

The properties of the resulting 3, 3-dimethylhexane: b. p.$_{754}$ 110.9°; $n_D^{20} = 1.4014$; $d_4^{20} = 0.7096$; $MR_D = 39.12$; calcd. for C_8H_{18} $MR_D = 39.14$.

3, 3-Dimethylhexane prepared by Schurman and Boord ([14]) had: b. p.$_{760}$ 110.7—111.2°; $n_D^{20} = 1.3992$; $d_4^{20} = 0.7078$; $MR_D = 39.03$.

1. It has been shown on an example of synthesis of 4, 4-dimethylhexene-1 from tertiary amylmagnesium chloride and allyl chloride that the latter may be used in the same way as allyl bromide and iodide for the direct preparation of olefinic hydrocarbons, comprising a quaternary carbon atom by the Grignard-Würtz method.

2. Physical constants of purer preparations of 4, 4-dimethylhexene-1 and 3, 3-dimethylhexane have been given than those available in literature.

Institute of Organic Chemistry.
Academy of Sciences of the USSR.

Received
12. III. 1943.

REFERENCES

[1] M. Tiffeneau, Bull. Soc. Chim., **29**, 1157 (1903); C. R, **139**, 481 (1904). [2] J. v. Braun, H. Deutsch und A. Schmatlock, Ber., 45, 1246 (1912). [3] B. T. Brooks and J. Humphrey, Journ. Am. Chem. Soc., 40, 822 (1918). [4] A. Kirrmann, Bull. Soc. Chim., (4), 39, 988 (1926). [5] R. Wilkinson, Journ. Chem. Soc., 3057 (1931). [6] A. P. Kozačik and E. E. Reid, Journ. Am. Chem. Soc., **60**, 2436 (1938). [7] F. C. Whitmore and A. H. Homeyer, ibid., **55**, 4555 (1933). [8] S. P. Mulliken, R. G. Wakeman and H. T. Gerry, ibid., **57**, 1605 (1935). [9] A. F. Platé and G. A. Tarassova, Bull. Acad. Sci. URSS, série chim., 201 (1941); A. L. Henne, A. M. Whaley and J. K. Stevenson, Journ. Am. Chem. Soc., **63**, 3478 (1941). [10] M. A. Dietrich and C. E. Boord, Ohio State University Abs., Doctors' Dissert., No. 14, 12 (1934); G. Egloff, Physical Constants of Hydrocarbons, I, 225. [11] F. C. Whitmore and D. E. Badertscher, Journ. Am. Chem. Soc., **55**, 2422 (1933). [12] Б. А. Казанский, А. Л. Либерман и О. Д. Стерлигов, ЖОХ, **13**, 125 (1943). [13] B. A. Kasansky, M. I. Rosengart and O. P. Solovova, Bull. Acad. Sci. URSS, série chim., 97 (1941). [14] J. Schurman and C. E. Boord, Journ. Am. Chem. Soc., **55**, 4930 (1933).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

GEOLOGY

ON THE STRUCTURE OF THE COAL-BEARING FORMATIONS OF THE CHUSOVAYA COAL REGION IN THE URALS

By P. V. VASSILIEV

(Communicated by P. I. Stepanov, Member of the Academy, 7. V. 1943)

The coal-bearing deposits of the Chusovaya region have been formed by three types of facies: 1) a shallow-water sea facies, leaving behind sediments of transitional zones; 2) a near-sea swamped lowland facies, deposing rocks of the coal-bearing zones, and 3) a water channel facies, forming the sand beds of the intermediate zones.

The coal-bearing formation of the Chusovaya region is composed of a total of nine zones (two transitional, four coal-bearing, and three intermediate ones), in the following sequence in the best prospected Obmankov and Skalnoye deposits.

On the eroded surface of Lower Tournaisian deposits (Kynov limestones) lies a marlaceous-clayey lower transition zone, containing thin flint streams in the Obmankov deposit, and a marine lagoonal fauna in the Skalnoye deposit. The maximum thickness of the zone is 25 m. Higher up it is followed by the first coal-bearing zone, containing thin coal seams in the Skalnoye deposit. In the Obmankov field this zone is lacking due to its subsequent erosion. Thickness of the zone—8 m.

The eroded surface of the first coal-bearing zone is overlain by the lower intermediate zone, composed of quartz sandstones and attaining a thickness of 12 m. The sandy deposits of the zone described upwards give way to areno-argillaceous rocks of the second coal-bearing zone, composed of up to 5 thin coal seams. The thickness of the zone attains 25 m. The zone has been eroded in some places to a depth of 18 m.

Upon the erosion surface of the second coal-bearing zone the sandy rocks of the middle intermediate zone were deposited, reaching a thickness of 20 m. Upwards these rocks give way to areno-argillaceous deposits of the third (main) coal-bearing zone, up to 55 m thick.

Within this zone there are up to 8 coal beds, of which seam No. 5 attains a partly workable thickness, but only seam No. 13 and partly seam No. 11 (the Skalnoye deposit) have a considerable extension.

The rocks of the third coal-bearing zone, as well as those of the other coal-bearing zones, have been subject to a regional erosional washing reaching 30 m. Upon the eroded surface of this zone, the sandy rocks of the upper intermediate zone were deposited, attaining a thickness of 35 m.

Higher up they give way again to areno-argillaceous rocks, in this particular case belonging to the fourth coal-bearing zone, up to 30 m thick. Within the zone described there occur up to 5 thin coal seams, of which two attain a workable thickness over limited areas.

The coal-bearing formation is crowned by the rocks of the upper transitional zone, reaching a thickness of 53 m.

From the above description it will be seen that the structure of the coal-bearing formation of the Chusovaya region is identical to that of the coal-bearing formation of the Kizel region (1).

This identity extends to separate coal beds. Thus, according to the investigations of M. E. Popova on the Skalnoye deposit the main working bed has a spore formula characteristic of bed No. 13 of the Kizel region. Likewise, according to T. I. Shlykova; spore analysis has established in the Bagul field coal beds Nos. 9; 11 and 13 (after the terminology of the Kizel region), confined to the same coal-bearing zone as in the Kizel region.

Hence the conclusion may be drawn that the coal-bearing deposits of the Kizel and Chusovaya regions enter into the composition of a unique coal-bearing formation which is a unique structural body that has originated at a definite time and occupies a definite stratigraphic position.

This fact is of decisive importance in the controversy concerning the beginning of deposition of the coal-bearing formation in the regions described.

As it is known, two opinions exist on the subject. Some investigators (V. Moeller, G. J. Zhitomirov, and others) think that the coal-bearing beds were deposited at different times in different portions of the Chusovaya region. Others; on the contrary, recognize the existence of an age break.

Starting from the considerations that the coal-bearing formation is a unique structural body, the beginning of its formation in every portion should have been approximately simultaneous geologically.

Therefore the fact of the coal-bearing formation over a considerable portion of the Chusovaya region overlying Lower Tournaisian limestones; while at other places it rests upon Upper Tournaisian deposits; might have been due only to a preliminary erosion of the latter.

As it will be seen from the above description; the zones of the coal-bearing formation of the Chusovaya region are situated in a certain alternating sequence, which causes its cyclic structure.

Into each cycle two zones enter: an intermediate (sandstone zone) overlying the eroded surface of the subjacent deposits, and a coal-bearing zone completing the cycle. A total of four cycles may be established for the productive formation of coal-bearing deposits.

From the thicknesses of individual zones and the rates of sedimentation of clastic material of a different coarseness, the conclusion may be arrived at that in each cycle the time taken by the formation of the coal-bearing zones is several times that spent in the deposition of the intermediate zones. For the Skalnoye deposit this ratio in the second cycle is equal to 8; in the third cycle to 11; and in the fourth; to 3.

Similarly, the time required for the formation of the second coal-bearing zone will be three times, of the third coal-bearing zone seven times and of the fourth coal-bearing zone four times that spent in the formation of the first coal-bearing zone.

Thus, the cyclicity of the coal-bearing deposits should be understood only as a recurrence of definite groups of deposits and by no means as their complete identity in time of accumulation and in thickness.

As to the structure of individual coal-bearing zones; it may be seen that arenaceous rocks, on the one hand, and argillaceous rocks; on the other, occur in a certain regular order; namely; the coal-clayey rocks, as well as sandstone rocks, compose rather persistent alternating horizons. In this respect the structure of the coal-bearing zones to a certain degree reflects on a miniature scale the structure of the coal-bearing formation itself.

To the sandstone intermediate zones here correspond sandstone horizons; and to the coal-bearing zones; coal-clayey horizons.

This resemblance is still more emphasized by the existence of erosions of the coal-clayey horizons, observed through the entire section of the third coal-

bearing zone of the Skalnoye deposit. These erosions preceded the deposition of the sediments of the sandstone horizons, similar to the deposition of the intermediate zones being preceded by an erosion of the coal-bearing zones.

Thus; in the structure of the coal-bearing formation a cyclicity on different scales is noted.

The main cyclicity; to which the cyclic structure of the entire coal-bearing formation is due; and which we have termed «macrocyclicity»; consists in a regular recurrence of the same type of rock complexes (zones) which are the chief element of the general stratigraphic scheme.

The cyclicity of the second order, which we have termed «mesocyclicity», is inherent; as we have seen; to individual zones whose structure it details.

There is moreover a cyclic habit of separate horizons which belongs to small-scale cyclicity phenomena; and which we have named «microcyclicity».

The principal cyclicity (macrocyclicity) has been caused by macro-oscillatory movements of the area.

The mesocyclic structure of individual zones has been produced by meso-oscillations of the area, which proceeded against the background of macro-oscillatory movements, while the microcyclic habit of the coal-clayey horizons has been caused by micro-oscillatory movements that occurred against the background of macro- and meso-oscillations of the area.

Received
19. V. 1943.

REFERENCES

[1] П. В. Васильев, Разведка недр, № 23 (1937).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

GEOLOGY

SIGNIFICANCE OF GEOSTRUCTURAL PROCESSES IN DEVELOPING PLAIN RELIEF

By J. D. ZEKKEL

(Communicated by W. A. Obruchev, Member of the Academy, 29. III. 1943)

1. The modern geomorphology, chiefly on the basis of the theories of W. Davis and W. Pank, attempts to ascertain the rôle and relationships of geostructural and exogenetic factors in the processes of shaping of the relief.

2. In practice, however, such a highly fruitful method of attack is used only with regard to the relief of mountainous countries. When analysing the development of relief of plain countries, it is usually silently understood that the exogenetic factors are of prevailing importance and determine all the principal features of the relief.

3. This view is not always justified. It is generally due to the fact that the attention of investigators is fixed almost exclusively upon the details (be it even the large ones) of the relief, and not on its principal features, such as the problem of origin of the plainness itself, of the configuration of the river network etc. As to the details of the relief, it is true that they are usually produced under the predominant influence of exogenetic factors, which cannot be in many cases said about the fundamental features of the relief.

4. It goes without saying that the processes which were having place in the more remote moments in the life of the Earth, are more difficult to interpret and; other conditions being equal, should be to a lesser degree reflected in the present shape of the surface than the younger processes.

Due to this fact, when considering the question of the origin of the relief of some country or other; in the vast majority of cases an exceptional significance is attached to recent factors; mainly, to Quaternary ones.

On the other hand, cases are not infrequent when the processes occurring in very ancient times leave a strongly pronounced imprint on the whole of the further history of the country and in particular on the evolution of its relief. In other words, the ancient factors sometimes prove to be more actual than the younger ones; since the other conditions are far from being always equal.

5. An example of a plain country, the relief of which in its principal features has been determined by geostructural processes which took place in the pre-Palaeozoic or early Palaeozoic time, is furnished by the territory located between the old crystalline Baltic Schield and Timan and occupied by the basins of the rivers Onega, partly North Dvina, Kuloy and partly Mezen.

Structurally, this region represents the northern extremity of the Russian platform, and the character of the evolution of its relief—it is true, only in the most general features—may be considered as the prototype of the whole platform.

6. The Onega—Dvina—Mezen region under consideration is a typical stable shelf (a steady plate) with a shallow-lying foundation of rigid dislocated pre-

Cambrian gneissose rocks. The depth of occurrence increases in an eastern direction. The surface is highly eroded. The rocks composing this base are sharply dislocated and strongly metamorphosed (i. e. have acquired rigidity) in the pre-Palaeozoic time. This rigid foundation is covered with a series of normal sedimentary rocks from the Middle Devonian to the Upper Jurassic inclusive (with some breaks in the sedimentation), and then by later Quaternary deposits.

7. The history of the country may be outlined as follows. After an intense crumpling and metamorphization of the old rocks composing the now rigid base; there occurred a prolonged period of washing, after which only during the Middle Devonian time the country was submerged by the waters of a shallow sea which left behind mainly red clays and sandstones, chiefly with a brachiopod uniform fauna. It is not easy to draw the boundary of these sediments with uniform greenish and red unfossiliferous sandstones and clays of the Upper Devonian. These continental, possibly partly near-shore deposits are replaced again mainly by red clays and sandstones, in the uppermost portion of which a poor brachiopod fauna of the Middle Carboniferous has been recently discovered. Very gradually they pass upward to marine limestones of the Middle and then Upper Carboniferous, distinguished by a very persisting character in the horizontal direction. When following the section upward, we may see how the Carboniferous sea dies out very slowly. At the beginning of the Lower Permian the marine limestones were replaced by lagoonal deposits in the shape of thick occurrences of gypsum anhydrites and primary dolomites with an impoverished fauna (mainly pelecypods and gastropods) of a Carboniferous habit, and then, at the end of the Lower Permian, the sediments are represented by near-shore continental unfossiliferous red gypsum-bearing marls and calcareous sandstones. Very slowly on the Lower Permian land the epicontinental shallow Kazan sea advanced, depositing at first only in the depressions of the relief fine-grained bedded sandstone with a mixed continental and marine fauna, and in the higher areas causing a washing of the underlying beds. This sea (its deposits are represented by clay marls, partly limestones) did not exist long. Its deposits gradually passed into near-shore, partly deltaic orange sands and red and greenish marls with a land fauna of reptiles of Tartar age, which were in turn covered with Lower Triassic continental terrigenous sediments. Subsequent to this the country lived through a prolonged period of denudation. The sedimentation was resumed only at the beginning of the Upper Jurassic time or possibly during the Middle Jurassic and continued with interruptions almost to the end of the Jurassic, continental sediments alternating with marine sediments. Beginning with the end of the Jurassic and up to the Quaternary, the country was an area of run-off and denudation. At last, in the Pleistocene it was repeatedly covered now with a continental ice sheet, and then—it is true; only in the peripheral northern parts—with a very shallow sea.

8. Most probably; in the Lower and partly Middle Devonian time the relief of the country was strongly dissected; for Devonian sediments lie upon a sharply uneven surface of old metamorphosed and dislocated rocks, but subsequently to this, in the continental stages of its history, the relief of the land was more or less in the nature of a plain, evidence of which is presented by the accumulation of comparatively fine-grained sediments of the Upper Devonian—Lower Permian (Vikhtov red beds), Upper Permian (Tartar stage) and partly Upper Jurassic. It is only among Lower Triassic deposits that conglomerates are present, but their part is insignificant, and they have been found only in the peripheral near-Timan part of the region.

At the moments when a break in the sedimentation occurred and the country was subject to washing (end of the Upper Devonian and Lower Carboniferous; greater part of the Triassic, Lower and Middle Jurassic, from the end of the Jurassic to the Quaternary time), its relief also approached mainly a plain one. This is seen from the nature of the contact of the series divided by periods of erosion. We have rarely observed basal conglomerates; the overlying rocks rest

on the slightly dissected surface of the underlying ones, the advance of the sea is usually of an ingressional nature, and its regression is expressed in a slow dying out.

9. All the above-listed palaeogeographical and palaeogeomorphological peculiarities are directly related to the tectonic history of the country.

Its main characteristic features are: (a) absence of any considerable plicative dislocations; (b) frequent epeirogenic oscillations, small in amplitude, but large with respect to the area affected; these oscillations bring about a frequent alternation of shallow-water marine, near-shore and continental sediments, on the whole of a small thickness. All of these are in turn determined in the main by the presence of a rigid base under the sedimentary series.

10. The absence of large-amplitude elevations and considerable dislocations, as we see, are throughout the long history of the country (beginning with the Middle Palaeozoic) the cause of the plain character of its relief. This is still enhanced by the fact that the country in the continental periods of its life was nothing else but the bottom of a shallow sea exposed to the day's surface. In other words, the frequent submergences of the country below sea level increased the plain character of its relief.

11. Due to the fact that; first; the epeirogenic movements more or less uniformly affected vast areas, and secondly, the rocks composing the territory lie almost horizontally, we see that some facies or others are located as wide well-persistent bands. Every facies, being uniformly resistant to erosion, creates favourable conditions for developing a plain relief within the territory of its superficial development.

12. The plainness of the relief was further enhanced by the small diversity in density of the rocks developed within the territory. And this in turn is directly related to the fact that the rigid foundation, preserving the overlying sedimentary series from strong pressure, prevented their metamorphism and intensive diagenesis. Thus, even some of the Palaeozoic sediments (sands, clays) here have been so little altered, that differ but slightly from Quaternary deposits.

Finally, due to the same protective action of the base, we do not find within the territory any rocks of igneous origin, which usually introduce, due to their density, a certain diversity into the relief of the country.

Among other things the small range of variations of the densities of rocks is reflected, along with other reasons, in the direction of the North Dvina river which flows not along the strike of the rocks; but across it, this fact influencing the valley but to a very small degree. On the other hand, the projection of hard crystalline rocks of the Baltic Shield; occurring in the way of the Onega river (flowing along the edge of the territory considered), strongly affects its direction (its eastern bend at the Biryuchev rapids).

13. From the above it follows that the endogenous geostructural processes are directly reflected in the relief of the country (§§ 9 and 10), but in addition to this exercise also an indirect influence upon it, to a considerable degree determining the geomorphological results of the activity of the subsequent exogenous processes (§§ 11 and 12). This influence will be the greater, the lesser the thickness of the mantle of Quaternary deposits, and the greater the part played by denudation processes among the later exogenous factors.

14. The various exogenous processes of Quaternary time, as the piling up of terminal-morainic ridges, digging or rejuvenation of many river valleys, formation of old coastal benches, coastal terraces, etc.; contribute but to a slight extent towards the diversity of the relief. The present climatic conditions and the character of the vegetation cover; on the contrary, contribute towards its smoothening.

Northern Geological Department.

Received
15. IV. 1943.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

MINERALOGY

ON THE MINERALOGY OF THE KARASSEV AND SOUTH-KONEV TUNGSTEN DEPOSITS IN THE CENTRAL URALS

By E. BOHNSTEDT-KUPLETSKAYA

(Communicated by W. A. Obruchev, Member of the Academy, 5. I. 1943)

The South-Konev and Karassev deposits, Bagariak district, province of Cheliabinsk, are confined to the eastern contact of the granite massif. They are separated from each other by a distance of 14 km.

The South-Konev deposit was discovered in 1930 by S. P. Kolodkin and worked since 1934. The Karassev deposit was first discovered by S. P. Kolodkin in 1932, but it was given due attention only in 1940 (V. Merenkov and I. Kogan), and is being worked only since 1941.

The South-Konev deposit is characterized by the presence of three systems of quartz veins distinguished by their strike, age and mineralization: 1) quartz veins of meridional strike (170—195°) dipping westwards 55—80°, from 0.5 to 50 cm in thickness (usually 6—8 cm), with a persistent thickness along the strike. These veins are genetically connected with the leucocratic granite and are intersected both by aplites and by younger tungsten-bearing and ore-free quartz veins. The alteration of the granite near the veins is manifest in their being enriched with light mica, fluorite, pyrite and molybdenite. The vein mineral is a compact grey and partly smoky quartz. Characteristic is the accumulation of sulphides usually confined to the marginal parts of the veins. Pyrite forms large crystals and segregations. Molybdenite is encountered exclusively in the contact and in the granite near the veins in the shape of small lamellae. Not so widely distributed are galenite, still forming locally rather large segregations, and light-yellow sphalerite. Fluorite is abundant, being associated with pyrite. Feldspar and beryl are rare, and singly observed are wolframite, scheelite and bismuthite. 2) These molybdenite-bearing veins, as well as the aplites, are intersected and displaced by younger tungsten-bearing quartz veins. They also show a persistent strike to the north-east (295—310°), and a dip to the north-west (65—85°). The veins are separated by a distance of 10—15 m (a total of 101 veins), and could be traced along many tens of meters and up to 400 m. Their thickness varies from 1—6 cm to 1.5 m. Sometimes they form swells, but are soon thinning out again and break into several veinlets. The granite near the veins was altered to greisen; this being evident from an abundant formation of muscovite and enrichment with fluorite and occasionally with scheelite. The quartz of these veins is light grey, showing a characteristic fracturing parallel to the vein walls. Only in the pockets is the lamination of quartz less strongly exposed. Along the lamination light mica is usually observed. The mica is frequently accumulated in the sahlbands, but the latter are in most cases worn to a great measure.

The chief ore mineral here is wolframite, while scheelite is rare. Within these veins, too, fluorite is abundant; it is usually associated with wolframite. Sulphi-

des are encountered as accessory minerals, forming irregular veinlets together with quartz of second generation. Of sulphides pyrite is observed, sphalerite in close paragenesis with galena, less frequently chalcopyrite and very rarely, pyrrhotite. Beryl is rare, being observed in the sahlbands, usually with fluorite. Wolframite is not uniformly distributed in the veins; sometimes it forms nests and tends towards the sahlbands, and sometimes its segregations are arranged in the shape of chainlets along the lamination of the quartz. Less frequently it is dispersed as small grains. The scheelite is by far not so widespread. In the veins of the central area it overgrows wolframite and forms veinlets and spots in the latter. Very rarely the reverse is observed, thin wolframite veinlets being present in grains and larger scheelite segregations. In the southern area, in a few veins which had evidently been formed at a lower temperature and are poor in fluorite, wolframite is absent, and the quartz contains only grains of light-yellow scheelite. In the upper parts of the veins, beside the above-listed minerals, manganic and ferruginous coatings and clay are abundant. Sometimes wolframite ocher is formed along with small segregations of malachite and azurite.

Finally in the South-Konev deposit a third system of veins has been established, showing a strike to the north-east (215—235°) and a 60—80° dip to the south-east and north-west; a non-micaceous sahlband is present here. These veins are filled with a low-temperature milky-white quartz, including druses of quartz crystals, and contain no ore-minerals, except a small quantity of pyrite.

At the Karassev deposit no such harmonious systems of different strike and mineralization are observed. No matter to what fractures they are confined, the veins here are tungsten-bearing and mineralogically identical. Besides, there are only a few low-temperature veins with milky-white quartz and quartz crystals, occurring chiefly in the north-western part. The surrounding granite is enriched with muscovite, sometimes with pyrite and fluorite.

We observe single veins with a steep dip (70—90°) and a different strike and a system of thin (5—8 cm on the average) flat-dipping veins (dip to the north-west 20—45°) with a persistent strike (220—230°), forming a stockwork zone in the north-western part of the deposit. Both types of veins are identical from the mineralogical point of view.

Single veins are extremely inconsistent in shape, being sometimes very thin over several tens of meters, after which they swell and thin out again, or divide into a number of veinlets. Occasionally their shape is more persistent; sometimes instead of veins lenticular bodies are encountered. No typical micaceous gauge is usually observed, though a certain mica enrichment is noted in the contact of thicker veins. Neither their structure nor shape are constant.

Mineralogically the veins of Karassev are poor. They are largely composed of compact greyish quartz with a characteristic lamination along the vein walls. The ore-mineral is wolframite which forms either small grains throughout the vein body, or pockets, or veinlets along the parting of quartz. In general wolframite accumulations are observed especially in the foot-wall. Muscovite in small lamellae forms bands along the quartz lamination. Common enough are separate pyrite grains (up to 1.5 cm), mostly replaced by limonite. A high content of such limonite is observed in the stockwork zone. In the quartz there is an abundance of ferruginous and manganic coatings. These minerals complete the list of the chief minerals of the wolframite veins of the Karassev deposit. Feldspar is present in small quantities, mainly in the vein walls. In some veins of the north-western area (veins 24, 26, 64) fluorite is observed in marginal parts; generally it is rare in this deposit, and only in one lens (vein 159) of the central area it forms large segregations, evidently confined also to the contact. In some portions of the veins, where wolframite is absent, compact non-laminated quartz is encountered; containing sometimes sulphide veinlets, pyrite and sphalerite with small quantities of bismuthite, and still less frequently, chalcopyrite. Beryl has been observed in small quantities in two veins only. Of secondary minerals wolfram ocher, limonite after pyrite, numerous manganiferous and ferruginous coa-

tings with an argillaceous matter, and rarely bismuth ocher and malachite are observed.

As may be seen, the number of minerals in each deposit is no great one, and about the same minerals are encountered in both, though in different quantitative relations.

The first phase of ore-formation which in the case of South-Konev deposit manifested itself in the formation of sulphide-molybdenite-bearing meridional veins, is absent in the Karassev deposit. In the South-Konev deposit the ore-bearing solutions of a later period, carrying tungsten, rised along persistent fractures of a north-western course, forming a system of similarly oriented wolframite veins. At the Karassev deposit the same solutions filled cracks of different directions and origin, creating a complex feature of the ore-field. The nature of the quartz and of the wolframite and their relations are identical in both cases. The wolframite is referred to the hübnerite variety with a considerable manganese content. Its crystals are imperfect, frequently they are broken or fractured. In thin-sections a considerable crumbling of wolframite is observed, the cracks and fragments in it being filled with quartz. On the other hand, as it has already been shown, wolframite veinlets along the lamination of the quartz are characteristic. The wolframite in both deposits is frequently found directly in the granite, either near the contact, or in the direction of disappeared veins.

An essential difference between the two deposits is the presence of a great quantity of fluorite in the South-Konev deposit, while in the Karassev deposit fluorite is rare. In the former case the solutions were more enriched with volatiles. The process of crystallization in the South-Konev deposit probably lasted longer. If the tungsten mineralization at the Karassev deposit was concluded by the formation of wolframite, at the South-Konev deposit wolframite was overgrown with scheelite; the abundance of late sulphides also points to a greater importance of the hydrothermal phase.

Though data on the mineralogy of the deposits discussed are of preliminary nature, yet it is well to point out that in searching for new points of tungsten mineralization in that region the presence of greyish «laminated» quartz is a more reliable guiding mark than the presence of fluorite in quartz veins. Another distinctive feature is the considerable greisenization of the granite near the tungsten-bearing quartz veins.

Received
5. I. 1943.

REFERENCES

[1] С. П. Колодкин, Отчет о развед. работах на месторождении вольфрам. руд... Челяб. обл., 1934. [2] П. К. Олерский и Р. С. Олерская, Отчет о геолого-развед. работах на Юго-Коневском месторожд. вольфрамита в 1939 г., 1940. [3] В. П. Покровский, Тр. Урал. науч. конфер., изд. АН СССР, 59—74 (1940).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

MICROBIOLOGY

MICROBE COMPLEX RESPONSIBLE FOR ROT OF SUGAR-BEET STORED UNDER CONDITIONS OF KIRGHIZIA

By B. A. RUBIN and O. P. PUSHKINSKAYA

(Communicated by A. N. Bach, Member of the Academy, 12. IV. 1943)

By the National War the sugar industry of our Central Asia Republics has been made to face a most important task—that of augmenting the quantity of sugar produced and thus to compensate for the loss inflicted upon sugare industry by the temporary occupation of a number of areas of sugar-beet cultivation by the German invaders.

During the first year of war the sugar-beet plantations in Kirghizia and Kazakhstan increased 3—4 times. In 1942 vast portions of ground were designated for this crop also in Uzbekistan which had never been engaged in sugar-beet cultivation before.

Such an enormous increase of the areas meant for the sugar-mills of Central Asia the necessity to protract the period of sugar making considerably: it had to be brought to 220 twenty-four hour days, and even more. This plan cannot be realized unless the problem of long storage of sugar beet is solved. The work to be done with this aim in view implies: 1) the study of the peculiarities of natural immunity of the local beet, 2) the analysis of the influence of the specific features of the climate on the resistivity of the root and on the course of storage and, finally, 3) the investigation of the composition of the microflore responsible for the rotting of sugar-beet during storage, the isolation of the active agents and the development of adequate methods for controlling them.

The present note contains the results of an investigation devoted to the last group of questions. After many years of researches it now seems to be firmly established that the relations between the root and the micro-organisms at the first period of storage offer the following picture. At the early, autumnal period of storage the most important rôle in the processes of beet affection by micro-organisms is played by fungic microflore. Bacteria are met with but occasionally at this period.

This circumstance is due to the fact that a freshly digged root which has not yet lost its natural resistivity, presents difficulties that are unsurmountable for the bacteria.

Among the fungi that attack the beet at the autumnal period of its storage in the European districts of beet cultivation *Botrytis cinerea*, *Phoma betae* and *Fusarium* sp. are the most active agents.

At subsequent stages of storage, as a result of unfavourable conditions such as excessive withering, abrupt changes in temperature, chilling, the immunity of the root becomes more or less weakened, which makes it liable to attacks by bacteria.

Of great importance here is preliminary infection of the roots with mould fungi, which is typical of the second half of the winter period of storage.

Towards the end of winter and especially during spring bacterial diseases become prevalent. The most active agents of spring bacterioses are to be considered *Bacterium betae flavum* and *B. betae culmorum* which produce viscid affections.

Investigations carried out by us during 1942—1943 in Kirghizia (Novo-Troizky sugar-mill) have shown that the development of microflore at different stages of storage proceeds there in a different way than in European districts. The main distinctive feature consists in that the rotting of the root is called forth not by a single agent, but by a whole complex, in which a very important part belongs to the bacterial flore. This becomes manifest at the very first period of storage, in early autumn. In a vast majority of cases as the most active components two species of bacteria are distinguished, referring to the sporeless forms. In what follows they will be termed Bact. 1 (Fig. 1) and Bact. 2 (Fig. 2), since the study of their biochemical properties has not yet been achieved. According to the type of growth, Bact. 1 should be classed with the mycobacteria.

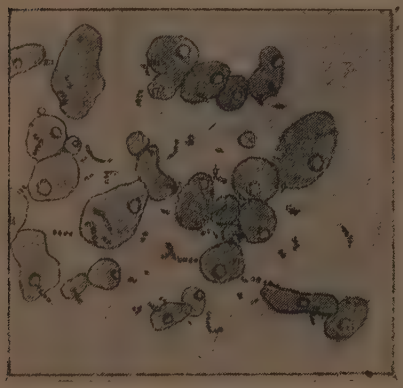


Fig. 1

Of less frequent occurrence; although playing an appreciable rôle in the rot of roots, is the third type of bacteria isolated by us, which belongs to sporulating forms of the type of *Bacterium macerans*.

The two non-sporulating bacteria are invariably accompanied by yeast of the group of *Saccharomyces*. And it is only at rare occasions that Bact. 1 can be encountered without yeast.

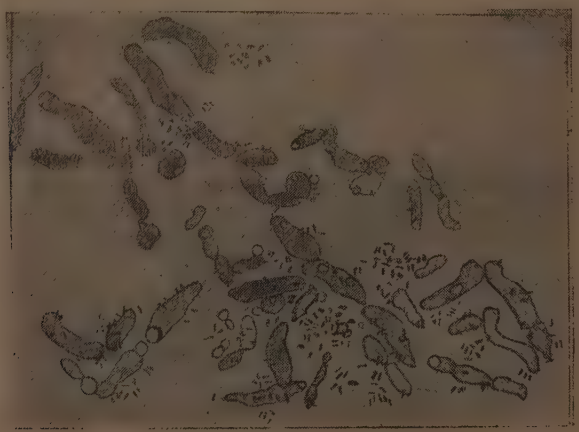


Fig. 2

The colonies of complexes Bact. 1 + yeast and Bact. 2 + yeast grown on beet agar; differ sharply as to their external appearance. The former complex forms diffused shapeless viscid masses; whereas the latter gives coarse; well shaped;

opaque; shrivelled colonies. An admixture of yeast makes the transparent colonies of Bact. 1 look turbid, and those of Bact. 2, opaque.

The relations between the bacteria and the yeast have been shown to be of symbiotic nature. This type of relations is especially conspicuous in the group: yeast + Bact. 2. The latter could as yet not be separated from yeast cells, on account of which the very fact of its independent existence seems rather doubtful.

The efficiency of Bact. 1 is sharply activized when combined with yeast; which is evidenced by the figures of the table (mean from several tests made on dozens of roots).

Intensity of Affection of Root of Sugar-beet (in grams of rotten mass)

Nos. of experim.	Bact. 1	Bact. 1+yeast	Bact. 2+yeast
1	3.75	32.0	33.7
2	3.25	10.0	8.25
3	2.45	7.45	7.35
4	6.70	7.15	7.60
Mean	4.04	14.35	14.23

On the other hand; the bacteria also affect materially the mode of growth of the yeast; under the influence of Bact. 1 and Bact. 2 the yeast cells are increased considerably; the budding process becomes more intense; Bact. 2, besides, causes the yeast cells to germinate in large numbers.

As a biological basis for this mutual influence may serve, on the one hand, substances of the group of bios, which are excreted by the yeast cells and which are necessary for the life of the bacteria; on the other hand, the formation of those substances may also be stimulated by some substances that are produced in the process of the life-activity of the bacteria. The type of root affection due to the two complexes is different in the case of artificial infection; and seems to depend on the general physiological condition of the host. Thus, on fresh, unwithered beet the bacteriosis covers rather extensive areas and but rarely has viscid character. More frequently dry; loose parenchymatous tissues; light-yellow in colour are formed. The rot is not accompanied by any odour variation.

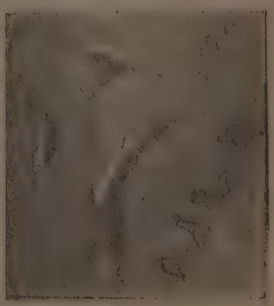


Fig. 3

Unlike this; roots with reduced immunity always show considerable mucosity at the spot of infection. It often penetrates deep into the root; whereby a strong odour of fruit-alcohol can be perceived. There are no changes in tissue coloration.

Along with mucosity; at separate places of the parenchyma of the affected tissue tears are formed that may occasionally attain considerable dimensions, which points to the presence of processes of tissue maceration. The above disturbances in the normal structure of the root tissue are of the nature of holes (Fig. 3).

It is of interest to note that by sowings made in order to determine the microflore of natural closed holes it proved possible to identify in them the very same Bact. 1 and Bact. 2, frequently combined with yeast. We think it probable that in the process of formation of holes in roots of sugar-beet; along with physiological factors (breaks of the tissues caused by irregular growth of separate areas of the parenchyma as a result of abnormal water-supply) an important part belongs to

microbiological factors. Subsequent work carried on in this direction has to find out the causes of hole-formation which is one of the chief ravages of the beet-culturé in the irrigated districts of Central Asia.

The general picture and the dynamics of the fungic flora is here essentially different from that common for all European districts of beet cultivation. In particular *Botrytis cinerea* which in Europe is the most active agent of root putrification at all stages of storage, has not been found in Kirghizia at the autumn period.

It appears only during winter and spring periods and then its appearance assumes a character of mass invasion. *Botrytis* is found in roots with a reduced natural resistivity. During the first periods of storage of fresh beet *Fusarium* sp. is of wide occurrence, which often enters as an active component into the bacteria-yeast complex described above. A much more important rôle than in European districts of beet cultivation is played by *Mucorales* fungi, which seems to be due to temperature conditions of the autumnal period of storage, more favourable for their development.

Institute of Biochemistry.
Academy of Sciences of the USSR.

Received
14. V. 1943.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

PLANT PHYSIOLOGY

CONTENT OF VITAMIN C IN WILD ROSES OF ARMENIA

By M. CH. ČAJLACHJAN

(Communicated by A. N. Bach, Member of the Academy, 15. V. 1943)

Among plants, wild roses are remarkable for the high content of vitamin C in their fruit. This anti-scorbutic vitamin plays a very significant rôle in the metabolism of both the vegetable organism that manufactures it, and of the body of man and animals. Investigations that were started not long ago have already shown that vitamin C, or ascorbic acid, affects the character of redox-processes, the activity of a series of hydrolytical enzymes, and, in the case of plants, takes part, moreover, in the processes of photosynthesis and growth.

But what has been established the most definitely, is that vitamin C is a most important and indispensable element in the nutrition of man. In the light of this statement it is easy to understand how essential it is to search for raw material resources that constitute the source of this vitamin. There are discovered many plant species, especially high in vitamin C—wallnut, gladiolus, actinidia, currant, pepper; and there is also a rather complete picture of the content of vitamin C in plant products.

Among all plants containing vitamin C first place is held by the wild rose, both because it is rich in vitamin C, and also on account of the presence in it of other important vitamins, viz. provitamin A (carotine), vitamin B_2 (flavine), etc. Within the genus *Rosa* itself, however, different species show wide fluctuations in their content of vitamin C ([1],[2]).

Now Transcaucasia, and Armenia in particular, display a great variety of soils and climatic conditions, and there is every reason to suppose that the rose here includes a very wide range of wild growing species; this suggests the possibility of finding among them some bearing fruit rich in vitamin C, whose content may vary, according to the species composition and under the influence of ecological factors.

A detailed and systematic investigation of the species composition of wild roses growing in Armenia was first carried out by Yaroshenko([3]). From his work it appears that the most richly represented species of Armenia are those referring to the section *Caninae*, and within this section two groups can be distinctly separated: Group I, *R. canina*, *R. corymbifera*, *R. tomentella* and *R. iberica*, enjoying a wide distribution all over Armenia and having in common the following taxonomic characters: at the beginning of fruit-ripening the calyx-leaves are turned down, grassy and quickly withering. Group II, species chiefly localized in the central part of the Armenian highlands (Abaran, Ashtarak and other adjoining districts)—*R. tomentosa*, *R. Boissieri*, *R. pulverulenta*, *R. caryophyllacea* and *R. Afzeliana*. The taxonomic characters common to all of them is that the calyx-leaves at the beginning of fruit-ripening are directed upwards, fleshy, coloured, and wither slowly.

From the other sections the occurrence of the following species has been established: *R. spinosissima* and *R. myriacantha* (section *Pimpinellifoliae*) and *R. haemisphaerica* (section *Luteae*).

I have investigated the content of vitamin C in the fruit of different species which Yaroshenko collected in different districts. The estimations have been done according to Tielmanns in fresh, ripening and ripe fruits. The flesh of the fruit separated from the seeds, 3—10 g in weight, was ground and extracted with a 2% solution of hydrochloric acid. After exposure for half an hour in darkness, filtration was made and the filtrate titrated with dichlorphenol-indophenol. Analyses carried out under participation of A. Gasparjan and R. Vlassenko, laboratory assistants, showed the content of vitamin C in different species of wild roses to vary within a wide range. It depends not only upon the particular species, but also upon the conditions of its growth (Tables 1 and 2).

Table 1

Content of Vitamin C in Wild Roses of Central Highlands of Armenia

Species	District of growth	Number of specimens	Content of vitamin C in mg %
R. Boissieri	Abaran (1900—2000 m)	1	3258
R. Afzeliana	Do	4	1319, 1643, 1698, 1829
R. caryophyllacea	»	5	1067, 1068, 1119, 1738, 1784
R. tomentosa	»	3	1036, 1682, 1912
R. pulverulenta	Ashtarak (1500 m)	1	1233

Table 2

Content of Vitamin C in Wild Rose Species Spread Throughout Armenia

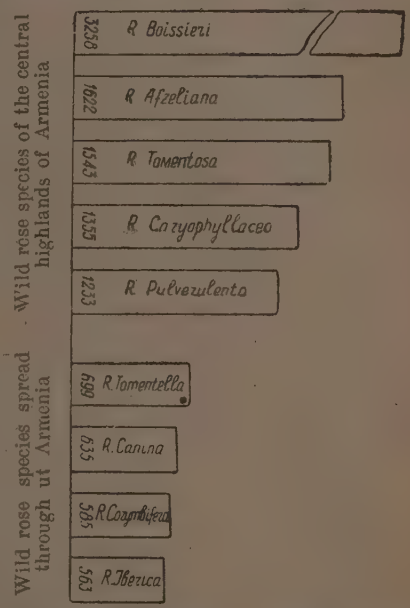
Species	Number of specimens	Content of Vitamin C in mg %					
		Allaverdy 700 — 900 m	Erevan 1000 — 1100 m	Megri 1200 — 1400 m	Kirovakan 1400 m	Martuni 2000 m	Abaran 1900—2000 m
R. canina	10	390, 414, 656	271, 889	153	527, 730, 743	—	1575
R. tomentella	4	627	—	703	304	—	1162
R. corymbifera	11	508, 536, 1055	353, 370, 411, 469	390, 780	687	—	878
R. iberica	1	—	—	—	—	—	563
R. spinosissima (section *Pimpinellifoliae*)	6	—	—	—	619, 1125	616, 626	850, 1442

The data first of all show that the content of vitamin C in the wild rose berries of Armenia is very high in individual species. Particularly remarkable in this respect is *R. Boissieri*, whose sweet and palatable fruits contain as much vitamin C, as above 3000 mg%. The content of vitamin C in other wild rose species of the Central highlands of Armenia fluctuates within 1000—2000 mg%. Therefore the generalization in Bukin's monograph (1) involving all southern species of wild rose, is not corroborated by either their species composition, or the content of vitamin C in their fruit.

These data bring into prominence a very essential difference between the two groups of wild roses. The species localized in the central highlands of Armenia are all much higher in vitamin C than those which are spread throughout Armenia (see figure).

In the first case none of the species has a content of vitamin C lower than 1000 mg%, whereas in the second case all species have a content ranging from 300 to 2000 mg%. This difference in the content of vitamin C that separates the species of the central highlands of Armenia from those occurring in every region of Armenia, can easily be traced in the classification made by Yaroshenko on the basis of taxonomical and ecological characters. A high content of vitamin C is therefore an internal biochemical characteristic that makes a part of the general complex of characteristics which is typical of the xerophyte wild roses of Armenia. This circumstance, in its turn, has permitted to establish a relation between ecological characters and the content of vitamin C. Attempts along this line have been made more than once ([2]). Comparisons between Yaroshenko's data and ours give every reason to believe that the wild roses, whose calyx-leaves at the beginning of ripeness are fleshy; coloured and turned upwards, are distinguished by a high content of vitamin C, and that character can be widely used in the mass collection of fruit for vitamin and in the evaluation of wild rose thickets as a resource of vitamin raw material.

The correlation between the form of the calyx-leaves and the content of vitamin C, as established here, refers to the species of the *Caninae* section. If, however, we take into consideration that *R. cinnamomea* and *R. acicularis*, which are species of another section, viz. *Cinnamomeae*; and are both high in vitamin C, likewise show raised calyx-leaves; it may be supposed that this correlation is one of a more general significance for the whole genus *Rosa*.



Content of vitamin C in wild roses of Armenia. The diagram is compiled from figures of Tables 1 and 2 by arithmetical averaging from all the determinations for each species

The wild roses widely distributed in different regions of Armenia exhibit considerable fluctuations in the content of vitamin C both within a single region and in different regions. This testifies to a considerable variability of this character according to the kind of soil and the climatic conditions. From the data of Table 2 it is seen that as the species move to higher regions with a dry climate, the content of vitamin displays a sharp increase. This should be interpreted to mean that the same conditions which in the process of phylogeny have made for the appearance of strictly localized and peculiar species with high content of vitamin are also working in this direction upon other species, increasing their vitamin content.

If the data reported in this paper are considered from the point of view of their direct application to practical purposes, one may draw a more general conclusion: the collections of wild rose fruit for vitamin in Armenia are in the first place to be made in the region of central highlands, for the wild rose species there are the highest in vitamin.

Institute for Plant Physiology. Academy of Sciences of the USSR;
Botanical Institute of the Armenian Branch
of the Academy of Sciences of the USSR.

Received
1. VI. 1943.

REFERENCES

[1] В. Н. Букин, Витамины, 201—302, 1940. [2] Н. Э. Шуберт, Тр. Всес. конфер. по витаминам, 125—127 (1940). [3] Б. В. Щербаков, Природа, № 1—2 (1942). [4] П. Д. Ярошенко, Изв. Арм. фил. АН СССР, № 1 (1943).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

EVOLUTIONARY MORPHOLOGY

FUNCTIONAL STRUCTURE OF *VALVULA FORAMINIS OVALIS* OF FOETAL HEART AND SOME QUESTIONS OF BLOOD CIRCULATION THROUGH *FOR. OVALE* IN HIGHER MAMMALS AND MAN

By W. N. SHEDENOW

(Communicated by L. A. Orbeli, Member of the Academy, 20. IV. 1943)

The present work was carried out on similar material and by the same method as that described in our previous note (1). *Valvula foraminis ovalis*, formed by way of transformation of *septum* I of the auricles, has commonly been regarded as consisting of a duplication of the endocardium; the *valvula* proper was thereby supposed to play in blood circulation through *for. ovale* a merely mechanical part of a simple lid.

We have established that towards the second half of the embryonic period contractile muscular elements are formed in the *valvula foraminis ovalis* between endocardium foliae. These muscular fibres show a regular and stable circular arrangement (transverse with respect to the longitudinal axis of the valve). This position holds both for the fixed type (valvular, coupling-like), and for the free type (pouch-type).

Being engaged in a rapid development; these muscular elements gradually increase in thickness towards the end of pregnancy and reach in big animals rather considerable thickness. They attain their maximum thickness at the base of the valve, where they seem to be continued from the miocardium of the auricles.

Spreading along the valve towards its end, the fibres thin out gradually; and usually extenuate altogether before they have reached the free margin of the valve and the elastic fibres which originate there. The muscular fibres of the valve are of miocardium type. Making morphologically part of the heart musculature; they develop independently at the expense of their own *anlage* of mioblasts which evidently originate in *septum* I. The valve of *for. ovale* thus has a peculiar muscular system of its own, belonging to the type of miocardium, and standing as to its development somewhat apart from the rest of the heart musculature. This relatively thick muscular layer of the valve is lined from both sides with endocardium; consisting of flat endothelial cells of the usual shape, and of an underlying layer of connective tissue, in which towards the close of the embryonic period elastic fibres appear.

Smooth muscular fibres are absent.

From what has been said above it follows that the valve of *foramen ovale* is no passive formation (of the type of a ventil), but should rather be considered as an active part of the heart itself (in particular, of the auricles), endowed with

contractility; owing to this; the shape and position of the valve change according to the phase of the heart work, and blood circulation through *for. ovale* is controlled.

Being a later onto-phylogenetic formation than the cardiac musculature proper, this peculiar muscular system is very interesting from the viewpoint of evolutionary morphology. In higher mammals and man it has to be referred to neogeneses that arise by way of deviation or even of anabolism; as a progressive factor in the general organization of the heart, it belongs to positive phylo-embryogeneses.

The development of this system is of exceptional functional importance, because it results in a general increase of the organism's life-activity.

At none of the life periods of the foetus does *foramen ovale* decrease in size, neither relatively nor absolutely, but it increases continuously, which is in accord with the ever increasing blood circulation through the heart and with its functional activity.

The question as to the nature of the placentary blood flow through *for. ovale* during the embryonic period should be revised. On account of its miocardium system the valve operates actively in accordance with the phases of the work of the heart. The period of its activity is, however, preceded by a period of inert state when the contractile elements have not yet been formed from the *anlage* of mioblasts. It may be assumed that in large animals the action of the valve begins towards the second third of the embryonic period. During its inert period, being a mere ventil, the valve can exert no appreciable controlling influence upon the blood stream through *for. ovale,* which is likely to proceed at both phases of the action of the auricles. During the diastole, owing to pressure difference in the auricles and the peculiar position of the limbus in animals and of the Eustachian valve in man, the blood streams freely from the caudal vein into *for. ovale.*

During the systole, the blood flow can also be supposed to be through *for. ovale,* since the valve cannot entirely prevent it, because the pressure in the left auricle must remain weaker as compared to that in the right one. At the period of its activity the valve already assumes a quite definite part in the control of the blood flow through *for. ovale.* Namely, contracting synchronously with the auricles, the valve tightly closes the orifice at the systole, even in spite of the difference that may exist between the pressures in the two auricles, opposing to it its muscular strength. The latter comes into operation but gradually, as the muscular system of the valve develops and becomes more vigorous. A tighter closure of *for. ovale* is also aided by the circular muscular fibres which towards this time have received considerable development and enclose the largest posterior part of the valve.

The above-said agrees fully with the fact that by this time the general quantity of blood has greatly increased as compared to the placentary period, and also with the increase in blood-pressure and in the size of *for. ovale.* The blood can now freely penetrate into the left auricle during the diastole only, while during the systole the whole of it is sent to the right ventricle.

It is the above-described process of gradual reconstruction of the blood circulation of the heart, taking place as a result of the valves having acquired the faculty of contracting actively, that we believe to account for the consecutive appearance of, and gradually increased partial isolation of the two halves, which precede their ultimate separation at birth. Thus, the formation and development in a foetus of a muscula system of the valve is historically determined and absolutely lawful. *For. orale* in man has some specific features which distinguish it from that in animals.

Aside from the peculiar transformations connected with *for. ovale*; *valvula venosa* and *tuberculum intervenosum* ([2], [3]); *for. ovale* in man is distinguishable for its relatively large size and rounded shape. In animals (especially; *Ungulata*) *for. ovale* has a more elongated shape and its position is an obliquely

vertical one, so that the upper end is directed upwards and backwards. This peculiarity should be explained in animals by a powerful development of the limbus, as well as by a narrower shape of the heart, associated with the shape of the lungs and thorax.

A larger size of *for. ovale* in man as compared with that in animals is probably due to a larger diameter of the *v. cava inf.* (as compared to *v. cava super.*), and, consequently, to a stronger flow of blood through it. This is evidently connected with a stronger development in man (because of its erect posture) of the pelvic extremities, as compared to the thoracic ones, and possibly also with a greater abundance of blood in the placenta ([4]).

Chkalov Agricultural Institute,

Received
20. IV. 1943

REFERENCES

[1] W. N. Shedenow, C. R. Acad. Sci. URSS, XXXIII, No. 1 (1941). [2] W. N. Shedenow, ibid., XXVII, No. 8 (1940). [3] W. N. Shedenow, ibid., XXIX, No. 7 (1940) [4] J. Barkroft, Physiol. Journ., XIX (1935).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

PALAEONTOLOGY

ON THE NATURE OF THE SYLVA REEFS

By M. V. KULIKOV

(Communicated by A. A. Borissiak, Member of the Academy, 27. VI. 1943)

On the left bank of the Sylva river, between the stations Kungur and Kishert, Permian r. w., as well as along the right bank of this river from Gamov Log to the village of Gribushino, there is a whole series of picturesque cliffs, composed of massive limestones, given by the local population different names, such as: Dyadya stone, Ermak stone, Koronka, and others. Most investigators who worked in this region, beginning with Stuckenberg ([6]), considered these formations as reefs. Under the term of «reef» in this area entirely different things were meant and different explanations were offered for the formation of cliffs.

The first explanation was given by A. Stuckenberg. He considered these formations as Upper Carboniferous stone ridges. Reefs, in his opinion, not as organogenous formations, but as stones, during the Artinskian time projected above the sea in the shape of a rocky island or peninsula. In the Kungurian time this stony ridge rose above sea bottom. A different interpretation of the Sylva reefs is given by Kruglov ([1]). He considers these formations as Artinskian and suggests a gradual transition of Artinskian reefs into Kungurian deposits. This author denies the absence of erosion of the Sylva reefs. The third opinion as regards the formation of the said reefs is that of Tolstikhina ([4]). Within the deposits of the Sylva reefs M. Tolstikhina separates out two horizons: a lower one, represented by organogenous-detrital limestones, and an upper one represented by reefs proper. According to the predominance of reef-forming organisms, the author refers the Sylva reefs to the bryozoa-brachiopod type. The insignificant thickness of the reef limestones, according to Tolstikhina, is evidence of the occurrence of erosion prior to the deposition of Kungurian dolomites.

On the Kolva river (Northern Urals), between the Vetlan and Boyetz villages, there are exposures of reefs, most probably of a similar age. Stepanov ([3]), who studied the brachiopods from the bryozoa-brachiopod reefs of this area, thinks that the reefs of the Sarga horizon represent only lenses embedded in stratified rocks. The reef configuration was the result of erosional activity and partial washing of the stratified limestones enveloping these lenses.

Each of the four above cases will be discussed separately.

1. The opinion advanced by Stuckenberg in his time concerning the Sylva reefs as Upper Carboniferous deposits, projecting above the sea in the Artinskian time in the shape of a rocky island or peninsula, is quite untenable, since in this region no Upper Carboniferous deposits exposed at the surface are present. The Sylva reefs, as it will be shown later, formed in the second half of the Artinskian age.

2. The most correct proved to be the view expressed by Kruglov as to the Artinskian age of the Sylva reefs and the probable absence of break in the deposits of the Artinskian and the Kungurian. This is evidenced by a number of facts

such as the gradual impoverishment of the fauna in the upward direction, a certain resemblance of the latter with the Lower Kungurian fauna, and the dolomitization of the upper part of the Sylva reefs.

3. The statement of Tolstikhina as to the small thickness of the Sylva reefs as a result of their having been eroded prior to the deposition of the Kungurian dolomites, seems to be hardly probable. The Upper Artinskian reefs in the vicinity of the town of Kungur actually are of small thickness. Their greatest thickness (Ermak stone opposite to the Chikali r. w. station) does not exceed 70—80 m. However, there are no reasons to speak of a washing of the Sylva reefs before the deposition of Kungurian dolomites. Tolstikhina refers the Sylva reefs to the bryozoa-brachiopod type. Such is the view held by many authors. Nearly all of the reefs of the Sarga horizon are considered as bryozoa-brachiopod ones, since bryozoans and brachiopods occur in this facies in great profusion. While engaged in the study of the Sylva reefs as organogenous formations, we have remarked (2) that the principal organisms forming biomorphic rocks are calcareous algae. On these grounds we considered (2) the Sylva reefs as algal.

4. Stepanov, as mentioned above, considers the Sarga reefs as lenses occurring among the rocks of the Irga horizon. This author considers as doubtful the existence of the Sarga deposits as an independent stratigraphic unit. A large number of sections of carbonate rocks on the Ufa plateau entirely disproves the suggestions advanced by the author named. In particular, if we take the section on the Sylva river between the Kungur and Kishert stations, Permian railway, we shall see that the Sarga reefs overlie the Irga silicified clayey limestones. The transition is rather a sharp one. Nearly similar cases were observed on the Igrin river by V. D. Nalivkin to whom I am indebted for the communication. Stepanov does not cite any direct proofs as to the inclusion of the Sarga reefs in the Irga stratified carbonate rocks, but arrives at this conclusion only on the grounds that the western facies of similar age both in the North Urals and in the Ishimbay oil region are represented by bedded limestones.

The Sylva reefs belong to the yongest reefs on the Ufa plateau, particularly, in its northern part. They were formed in the Upper Artinskian time. Their insignificant thickness indicates a short duration of their growth.

In the Sylva reefs a very rapid change of organic remains in an upward direction is observed. This enabled three formations to be separated out (in ascending order): the large brachiopod, the algal-polypore-*Marginifera*, and the small brachiopod-*Fenestella* series. Of the first two, especially of the second, an incrustational structure and a high content of organic remains are characteristic. In so far as these reefs were growing at a shallow depth and continually suffering the destructive action of sea water, this fact influenced to a considerable extent the distribution of organisms which lived here and built the reefs. The forms most resistant to the water movement settled along the margins of the reefs, while the less stable forms settled nearer the central part of the reefs. Bissus forms of pelecypods, brachiopods attached with their pedicle to the substratum, are found most frequently in a large number in the marginal zones of the reef. Bryozoans and algae with a more brittle skeleton in these areas are, as a rule, in a highly broken condition. In the central part their skeletons are fully preserved.

The Sylva reefs were most probably growing in the zone of a shallow open sea, to which no terrigenous material could be supplied. This is indicated by the considerable purity of the limestones. A large accumulation of calcareous algae in the Sarga reefs, most probably belonging to green algae, points to the existence of a warm climate and of shallow depths of the basin.

Towards the close of the Artinskian age the Sylva reefs had completed their growth. The dying out of the growth of the reefs proceeded slowly and affected very strongly the nature of the organisms inhabiting the reefs. In the upper portion of the latter the fauna is very small and sparse. It is represented by small scarce brachiopods; small and still scarcer bryozoans; chiefly belonging to *Fenestellidae*. Sea lilies seem to have been rather small too, as it may be judged from

their remains. Pelecypods are very scarce. Thus, instead of the rich fauna and flora in the lower and middle parts of the reef, in the upper portion but traces of some classes of invertebrates have been preserved. These suppressed and stunted organisms settled on a detrital substratum. In the upper part of the reefs the limestones are detrital, highly dolomitized. The composition of the fauna, its suppressed nature, sharp impoverishment, the dolomitization of the detrital rocks—all of this justifies the assumption as to the cessation of growth of the Sylva reefs at the end of the Upper Artinskian age as a result of an increase in the salinity of the basin, a certain separation of it. Following the cessation of growth of the Sylva reefs, within this area the Fillippov dolomites of the Kungurian began to deposit.

Shamov ([5]), unlike the other investigators who studied the reefs of the Ishimbay oil region, sees the causes of their dying out in a considerable deepening of the basin. The latter, according to this author, was the chief reason of the cessation of growth of the Ishimbay reef massifs. Other investigators have ascribed the cessation of growth of the Ishimbay reefs to a contamination of the waters of the Chladochonus sea with terrigenous material. As is seen from all the afore said, neither assumption offered to explain the cessation of growth of the Sylva reefs is acceptable. The reefs ceased to grow as a result of an increased salt content in the basin separated from the world ocean.

Palaeontological Institute.
Academy of Sciences of the USSR.

Received
11. VII. 1943.

REFERENCES

[1] М. В. Круглов, Труды ВГРО, вып. 279 (1933). [2] М. В. Куликов, Рефераты работ Биологич. отд. АН СССР за 1940 г. (1941). [3] D. L. Stepanov, Bull. Acad. Sci. URSS, sér. géol., No. 5 (1940). [4] M. M. Tolstikhina, Vademecum of the XVII Int. Geol. Congress. Permian excursion. Northern route, 1937. [5] Д. Ф. Шамов, Сов. геология, № 11 (1940). [6] А. Штукенберг, Труды Геологич. ком., XVI, № 1 (1889).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1943. Volume XL, № 9

HELMINTHOLOGY

TREND OF EVOLUTION IN TREMATODES OF THE FAMILY *PHILOPHTHALMIDAE*

By A. A. SOBOLEV

(Communicated by K. I. Skrjabin, Member of the Academy, 26. IV. 1943)

The family *Philophthalmidae* Travassos, 1918 (*Trematoda*) is of interest as a relatively small, but clearly delineated taxonomic group, characterized by its adaptation to parasitic life partly in the digestive tube, partly in the orbit of birds.

In the present work an attempt is being made to analyse the morphological features of the genera composing this family, with the aim of elucidating their phylogenetic relations and the principal trends in their evolution.

While treating the material collected by the 184th All-Union Helminthological Expedition, we subjected to investigation the parasites found in the orbit of a *Numenius arquatus*, which according to their morphological characters belonged to the family *Philophthalmidae*, but could not be referred to any of the genera known.

We suggest to rank this form as a new genus, *Ophthalmotrema* n. gen. under the following diagnosis: *Philophthalmidae*. Body flattened, with clear-cut constriction in the middle part at the level of abdominal sucker. Oral sucker subterminal. Prepharynx absent, pharynx round. Oesophage long, passing into intestine ramifications at a half distance between oral and abdominal sucker. Abdominal sucker larger than the oral one. Testes arranged one behind another, obliquely with respect to the median line of the body. Sexual bursa large, its bottom reaching almost the posterior edge of abdominal sucker. Ovary situated anteriorly to the testes, nearly on the median line of the body. Vitellaria consisting of a few coarse follicles, originate in the middle of the posterior section of the body separated by a constriction; they reach the level of the posterior testis. Uterus behind abdominal sucker. The eggs contain formed miracydia with pigmented ocelli. Parasitic of the orbit in birds. Typical and for the time being unique species: *O. numenii* nov. gen. nov. sp.

This species possesses the following characters: length 3.696—3.840 mm; maximum width (at the posterior part) 1.634—2.169 mm. Oral sucker 0.374—0.489×0.459—0.510 mm. Abdominal sucker 0.763—0.639—0.766 mm. Pharynx 0.321—0.306×0.255—0.306 mm. Anterior testis 0.221—0.276 mm across, posterior testis 0.272—0.293 mm across. Bursa of cirrus 1.020×0.102 mm. Ovary round in shape, 0.187 mm across. Length of eggs 0.069—0.081×0.033—0.36 mm.

Host: *Numenius arquatus*. Localisation: orbit. Finding place: Gorky department (USSR).

According to its morphology, the genus *Ophthalmotrema* n. g. approaches the most closely to the genus *Pygorchis*. The main morphological distinctions consist in that in *Ophthalmotrema* the body is divided by a constriction into two parts, and in a developed oesophage, both characters lacking in *Pygorchis*.

Thus, the family *Philophthalmidae* comprises five genera: 1) *Philophthalmus* Looss, 1899; 2) *Pygorchis* Looss, 1899; 3) *Parorchis* Nicoll, 1907; 4) *Cloacitrema* Yamaguti; 1935; 5) *Ophthalmotrema* n. g.

The Trend of the Phylogenetic Evolution in the Family *Philophthalmidae*. Discussing the question as to the phylogenetic relations among the *Trematoda*, K. I. Skrjabin ([3]) and partly V. D. Semenov ([4]) stressed the great significance of such a character as the degree of development and the topography of the reproductive system.

According to this character, three groups are to be isolated within the family *Philophthalmidae*: the first, comprising the genera *Cloacitrema* and *Parorchis* in which the testes are arranged side-by-side; the second, characterized by an oblique arrangement of the testes, comprising the genera *Pygorchis* and *Ophthalmotrema*, and, finally, the third one, enclosing a single genus, *Philophthalmus*, in which the testes are arranged one behind the other. The arrangement of ovaries and vitellaria, as well as of the uterus, is rather monotonous in all the genera of *Philophthalmidae*.

The representatives of *Philophthalmus* and *Ophthalmotrema* inhabit the orbit; the rest of the genera, the digestive tube and mainly the cloaca of birds.

Now, if we abord the question as to the ways passed by the evolution of this family, we are led to conclude, in the first place, that the least specialized are the genera *Pygorchis* and *Cloacitrema*. *Cloacitrema* seems, besides, to be a more primitive genus than *Pygorchis*, since, if we start from the statement made by Skrjabin ([3]) that the increase of the elements of the sexual system is the most important point in the evolution of parasitic forms, then the oblique arrangement of testes typical of *Pygorchis* is more promising with respect to their possible increase than their arrangement side-by-side, as in *Cloacitrema*.

The genus *Parorchis* is considered by us as a group which went through a more perfect adaptation to its surrounding medium; this has found expression in the development of a new fixation organ, the peri-oral collar, as well as in the outlines of the body, which reminds an isosceles triangle with its apex at the anterior end, which makes them look like the typical inhabitants of the cloaca, the representatives of the genus *Prosthogonimus*.

Such is the original and most ancient branch of *Philophthalmidae*, parasitic of the digestive tube. Its descendants are the genera *Philophthalmus* and *Ophthalmotrema*.

The ancestors of both genera must have had an organization similar to that of *Pygorchis*; in the case of *Philophthalmus* there took place alteration of the sexual glands: in the representatives of this genus the testes are arranged one before another.

Such an arrangement of the testes may be regarded as the climax of the developmental trend traceable in the genus *Pygorchis*. The testes are larger as compared to the general body dimensions of the parasite, this relation being more pronounced than in the rest of *Philophthalmidae*; the same must be said of the other components of the reproductive organs of *Philophthalmus*.

The second genus of *Philophthalmidae*, parasitic under the eye-lids of birds, is similar to *Pygorchis* as to the arrangement of sexual glands. It has, however, acquired a new character, its body being separated by a constriction into the anterior and posterior part.

We had occasion to observe these trematodes *in vivo* during the work of the 184th All-Union Helminthological Expedition, and would say that their movements are much alike those of typical *Strigeidae*, which show a similar constriction of their body.

Conclusions

Two branches enter into the composition of the family *Philophthalmidae*. The one, which is the most ancient, is characterized by its representatives being parasitic of the digestive tube of birds. The original, most primitive

genus of this branch is the genus *Cloacitrema*. This genus gave, on the one hand, rise to the now florishing genus *Parorchis* that worked out new adaptive characters; on the other hand, to the genus *Pygorchis* that developed progressive changes in the structure of its sexual apparatus.

The genus *Pygorchis* gave origine to the second branch of the family, which became adapted to inhabit the orbit of birds. This branch diverged into the genus *Philophthalmus* which, along with the genus *Parorchis*, may be regarded as a florishing one, being parasitic of birds belonging to diverse orders, occurring in different parts of the world and being relatively rich in species, and the genus *Ophthalmotrema*.

The morphology of the genus *Philophthalmus* is remarkable for the fact that it achieves the reconstruction of the sexual system which had been started in *Pygorchis*. The genus *Ophthalmotrema* has acquired a new feature in the configuration of its body, which may be considered as an adaptation to the medium it inhabits.

Department of Zoology.
Gorky Agricultural Institute.

Received
26. IV. 1943.

REFERENCES

[1] А. З. Ефимов, Сборн. посв. 30-летию научн. и общ. деят. К. И. Скрябина, М., 1937. [2] Yamaguti, Japan Journ. of Zoology, VI, No. 2 (1935). [3] K. I. Skrjabin, C. R. Acad. Sci. URSS, XXXIII, 468 (1941). [4] В. Д. Семенов, Сб. работ по гельминтологии, посвящ. К. И. Скрябину, М., 1927.

Prix $ 0.50